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CORNELL STUDIES IN DYNASOMATIC PSYCHOLOGY

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There follow six studies from the Graduate Laboratory of Cornell University. These studies represent that part of our program of research for last year which centered in operational description. In the phraseology of the laboratory, the studies are functional in the sense that they bear upon activities of the living body. Since they assume no mental or 'psychic' forces of a causal kind, to be added to bodily energies, the temper of the studies may be called 'dynasomatic.' Their approach to research lies parallel to that of the physiologist, who likewise observes and describes functional activities of the body.[1]

Four of the articles which follow are based upon doctoral researches: two were written by candidates for the master's degree. Although the titles suggest a wide variety of topics, the writings are nevertheless closely related. In the first place, they are attacks upon a common descriptive problem and, in the second place, they adopt a common method of observation and interpretation.

Since these studies mark the latest stage of a program of experimental

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[1] When used adjectivally to define a particular kind of psychology, the term 'functional' is wholly undiscriminating. Well over half of all psychologies ever written have been functional. That is to say that they have treated of the nature and operations of the soul, of the mind, of a knower, willer, passive sufferer or learner, of the adaptive give-and-take between organism and environment, of conscious agents, configurations, and much besides. At the moment, the strongest connotation of 'functional' in psychology doubtless implies an American variety proposed forty years ago as a counterblast to 'structuralism.' It stood for the biological efficacy of consciousness in man's struggle with nature. In point of view and of method the present studies stand unrelated to all these historical forms of 'functionalism.' The adjective in the title only implies that the living physical system is the sole authentic agent and actor, whether the organism is active in the ways commonly studied by the physiologist and his kind or active in the ways which the psychologist alone, as matters now stand, is (or may be) prepared to observe, describe and explain.

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investigation which has occupied the writer and his associates in research for a fairly long term of years, a brief review of the program and of its general setting in psychology may be prefixed here as a prologue to the six researches.

The general proposal underlying all the studies rests upon the conviction that neither older nor current psychologies have provided an adequate and coherent description of observable activities of man.[2]

Older analyses of mind or consciousness professed to exhibit and define elementary structures (sensations) and to relate them both to receptoral organs and to exciting stimulating conditions. These analyses led to a useful description of certain simple constellations. Not much beyond this point did the 'structural' assumptions and methods successfully go. Attempts to proceed toward the more complex and the more concrete were proposals for combining qualities,[3] for similar memorial elements (Külpe, Ebbinghaus), for an apperceiving process with its central organ (Wundt), for an extension to affective, conative and other elements (Titchener, Ebbinghaus, Stout, and many others), for an associative principle of integration (Bain, Ward, Ziehen), and so on. But none of these attempts really carried psychology into the higher ground of resolve, understanding, invention, constructive thinking, and the like. The direct attack of the elementalists on thinking (the Würzburg school, Titchener) did not succeed because it attempted the impossible. James did better, but his method was casual depiction and his central field of interest was epistemology.

The *venue* of psychology was radically changed by the early behaviorists, who turned their attention to animal movements (responses) and their antecedent conditions (stimuli). In spite of the very great accomplishments of this oblique approach to psychology, the behaviorists have made almost no headway toward those activities of man (vaguely called 'the higher mental processes') which have their *main* seat within the organism and not in environmental exchange.

A new extension of psychology by experiment followed Ebbinghaus' proposal for the use of nonsense-syllables. The net result (practical applications aside) was a measured assessment of associative output as dependent upon outside and sensory conditions. Very little was added to our knowledge of the actual functions involved in 'memorizing' and 'reciting.' Its success and acclaim were due to its measurement of the output of 'learning.'

The method of tests, which was widely used by psychologists as early as the '90s, likewise dealt with measured output (product, accomplishment) and its interpretation in terms of intelligence. It has added but little descriptive knowledge on the process of 'intelligent' activity and its bodily conditions.

Obsessed by the belief that any descriptive account of perceiving, choosing, re-

[2] Compare psychology with physiology. In spite of the unfinished state of the latter subject, it nevertheless possesses a point of view of bodily process, a command of terms, concepts, and working equipment, a working alliance with related sciences, and a command of appropriate procedures which enables it to solve its basal problems. The same cannot be said of psychology, which has for generations attempted to provide—with a modest degree of success—a different sort of account of living.

[3] *Cf.* M. Bentley, The psychology of mental arrangement, this JOURNAL, 13, 1902, 269-293.

membering, acting, and the like necessitated an appeal to consciousness, the behaviorists rejected these terms and assumed that a quantitative causal relation could be made out as between the stimulating environment and ensuing movements. The resulting program naturally threw little light upon actual operations of the organism, save those limited physiological processes directly involved in stimulation and response. It has provided a useful external account of the simpler mobile activities of many animals, but little information on the actualities of man's daily living among his kind.

It was a fortunate circumstance that the principle of configuration was generally disseminated at the time when our program was taking shape, important less for the doctrine of *Gestalt* and the theoretical discussions which came from it than for the configurationist's protest against sensationalism and other excesses of analysis and against the point-to-point parallelism between sensation and stimulus or between stimulus and response. *Gestalttheorie* supplied a very effective criticism alike to the psychologies of consciousness and the psychologies of behavior. Its negative benefits were accessible to all. The notions of membership and patterning also were usable in perception, though the 'priority of the whole,' the mystery of 'insight,' and 'field-dynamics' have scarcely been conducive to factual description in fluid terms.

Finally, an examination of the literature of psychology for empirical principles and methods reveals a strong predilection running through our history for assumed forces and powers. A review of 'dynamic psychologies'[4] from ancient times to Bergson, James, Woodworth and MacDougall has recorded the wide range and variety of dynamical concepts imported into our field, an importation which "has led to an illegitimate substitution of forces and faculties" for empirical description. Any account of function or activity has especially to guard against the elevation of assumed forces into explanatory causes or faculties.

A psychology whose subject-matter was conceived as an interrelated group of psychosomatic functions at first promised to supply the basis for a general descriptive account.[5] At least the notion of a *psychosome* accorded with the common and current notion of mental agencies amalgamated with bodily operations. The view did not, however, really escape an old and pernicious dualism; and, furthermore, it retained the old structuralistic distinction of mind and meaning, the latter being the specific creation of the former.

The attempt of the writer to approach the problems of psychology in an operational way is illustrated by a study of perception carried through under his direction two decades ago.[6] By no means released from the sensationalistic bias, the research is an unsatisfactory compromise between the view that perception is a complex of elementary qualities (a perception) and a clear functional consideration. The result is in part a cata-

[4] M. Bentley and others, Dynamical principles in recent psychology, *Psychol. Monog.*, 30, 1821, (no. 136), 1-16.

[5] For a survey and exposition of the psychosomatic organism, see Bentley, *The Field of Psychology*, 1924, 1-545.

[6] A. S. Rogers, An analytic study of visual perceptions, this JOURNAL, 28, 1917, 519-577.

logue of sensations and images reported in simple perceivings and in part a description of functional course, a course which is half a sequence of 'mental processes' and half a characteristic operation with characteristic object-products (called 'meanings'). In keeping with the times, emphasis was laid upon attention, clearness, and the strict correlation between 'process' and 'meaning.' For the Laboratory, the most instructive issues of the study were (1) the wide draft made upon the organism for the swift and adequate apprehension of simple objects and events and (2) the discovery that this operation could be variously used (by the integration of specific bodily resources, receptor, muscle, viscera, brain, and so on) for grossly configuring, depicting, abstracting and generalizing, the end of the operation being determined in part by a special accent upon one or another bodily resource and in part by the nice adjustment of one temporal phase to another.

This study led, in the Illinois Laboratory, in three main directions; toward (i) the dependence of function upon 'instruction' and other antecedents, (ii) the processes of search and anticipation, and (iii) the adumbration of 'thinking' in operations so simple, brief and elementary as the apprehending of simple objects. This research had the effect of re-orienting its writer and its director toward functional descriptions.

Three subsequent studies took into account these three primary hints. One was a quest for functional antecedents. The outside setting for this study is to be found in the established experimental procedure of preparing the observer through a verbal caution that such-and-such an occasion is about to be presented and will demand so-and-so of him by way of observation and report. Careful experimenters had long since discovered that a meticulous preparation and presentation of this *formal instruction* was a primary means of controlling the organism and determining both his activities and his report. It was only later that behavioral experimenters made the same discovery and put it into practice by way of organic tuning and preparation. Recent refinements of the conditioning methods bear very directly upon this point.[7] The problem of antecedents profited by the experimental verification of the task or *Aufgabe* (Ach, Watt, Messer and others) and of the effects of 'set,' 'predisposition' and 'trend.'

Our own study of instruction used printed sentences (with and without word-spacing), puzzles, coding, and hidden phrases.[8] Observers' re-

[7] *E.g.* W. J. Brogden, E. A. Lipman and E. Culler, The rôle of incentive in conditioning and extinction, this JOURNAL, 51, 1938, 109-117.

[8] O. F. Weber and M. Bentley, The relation of 'instruction' to the psychosomatic funciton, *Psychol. Monog.*, 35, 1926, (no. 163), 1-15. "We have found these instructions to be more numerous and more varied than experimental procedure commonly assumes. They are conditions of functional output which are almost

ports covered the functions used, together with their antecedents and their products. It appeared, in the results, that tasks of these sorts are copiously introduced not alone by the verbal instructions, but also by the presented occasion itself (*occasional instruction*) and hints which the organism gives itself (*self-instruction*). All these forms have since become commonplaces of careful experimentation (with animals as well as man); but at the time they served us as an important methodological refinement which was to throw a strong light upon the operations and processes of the organism, both in the laboratory and in daily life.

The second new direction of research was toward a new functional mode. Perceiving and thinking had long been regarded by psychologists as standing in sharp contrast. Perception has for ages been looked upon as at least half physical, thinking as 'purely mental,' a view which obviously confuses operation and operational outcome or product. Falling into this confusion, modern structural psychologists sought—practically without success—for distinctive elements of thinking (*Gedankenelemente*). Since the Rogers study had revealed intermediating operations, we were on the alert for more. A ligating form we seemed to find in an inquisitive kind of anticipative inquiry which we provisionally called *search*.[9] Perceiving we found to be essentially an *apprehending* function, thinking an *elaborative* function, and searching a *puzzling scrutiny* akin to both. The experimenter made use of pictures (reproductions of paintings and cuts). During or after the visual presentation, *O* (who had been formally instructed) was asked a question. 'P-questions' bore upon some prominent object or phase in the presented scene (*e.g.* 'Is the tree one-sided?' *e.g.* 'What is going on?'). These questions encouraged perceiving. 'T-questions' demanded the use of clues (*e.g.* 'What time of day here?' [moon or shadows in the scene], *e.g.* 'Were the trees planted by man?'). They induced *O* to go beyond the picture and elaborate a solution—especially when they were asked just as the exposure closed. Finally, 'S-questions' bore upon hidden or concealed details (*e.g.* 'Where is the third animal?' *e.g.* 'What is he looking for?'). A given picture was shown with P-, T-, and S-questions on different days.

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wholly neglected by the 'test methods' and by the behavioristic correlation of stimulus with response. It appears that they should also be taken with greater seriousness by the descriptive psychologist, who is inclined to rely too confidently upon the formal command as the essential determinant of a psychological operation."

[9] H. L. Kingsley, Search; a function intermediate between perception and thinking, *Psychol. Monog.*, 35, 1926, (no. 163), 16-55. "Perception . . . has been regarded as a form of passive receptivity . . . dealing with the sensuous and earthly; while thinking . . . has been magnified and extolled as . . . an active, creative accomplishment capable of transcending the senses" (p. 17). *Cf.* this JOURNAL, 44, 1932, 314-318; 46, 1934, 437-442.

The central distinction between perceiving and searching appears just after the question is comprehended and the organism is thrown into commission for the one ('apprehend and identify that which is asked for') or the other task ('scan the scene until the desired object is sought out and identified'). Differentiating details in the two operations may be omitted, except that searching is akin to simple forms of acting and makes specific use of kinetic devices of the body. The central distinction between searching and the instances of thinking which our experiments induced likewise comes out after the comprehension of the question. Both set goals and proceed toward them, but whereas the searching-goal is to be found (by apprehending and identifying) as an item in the picture, the thought-goal is elsewhere and is reached by other means, *e.g.* by the creation of 'symbolic' materials which take the organism beyond the presented scene to a bit of new knowledge, an opinion, a guess, or a conviction. The use of this material to advance to a goal which will satisfy the task implied by the question we may for the present call *elaboration*. The experiments taught us that elaborating calls for a functional fusion of apprehending (perceptive, memorial and imaginational) with search and with comprehending. Though we caught various 'symbol-objects' (often words) which aided the search, and which were, so to say, rollers upon which elaboration slid forward, the precise nature and office of them had to be left for later studies. Further issues of the research were, first, the very large part played in all three functional modes by all three forms of instruction, and, secondly, the part played in searching (under our conditions), and in elaboration as well, by the presented scene, *i.e.* by the products of perceiving. Searching includes, but goes beyond, perceiving; while thinking includes, but goes beyond, searching. While many phases of searching and thinking remained to the future and while searching was later to stand less simply as an intermediate mode, its hypothetical existence served here to suggest a turn in experimentation which has finally brought out the family relations of perceiving and thinking and has ended the tradition of opposition and "sharp contrast."[10]

A somewhat earlier study of 'imagery,'[11] while it was partly set in the old context of 'ideas' and 'attention,' brought us new information upon those products of memorial and imaginational operations which Rogers

[10] On the basis of our factual results, we came to distinguish 'perceptive searching' and 'elaborative searching' (p. 55). Later we were to find still other adjectival varieties. The empirical treatment of thinking in *The Field of Psychology* (1924) stands related to this study.

[11] H. Clark, Visual imagery and attention: An analytical study, this JOURNAL, 27, 1916, 461-492.

and Kingsley had found to be implied in the more abstractive and generalizing forms of perceiving and in searching and thinking. Moreover, the study set a definite relation between the various classes of image-object and those apprehensive modes of remembering and imagining which produce them. Thus was the way opened for a parallel examination (see Erb, below) of the three main forms of apprehension. Furthermore, two specific issues of the research on image-objects proved to be useful in the development of our functional chart (p. 222, below), whereon we have attempted to depict in genetic interrelation all of the primary functions, together with certain fundamental modes of functional combination. The first issue is that 'attention' resolves itself, for this context, into a functional mode which we have since called inspecting or scrutiny and which may or may not appear with perceiving, remembering or imagining, but which is more naturally allied to perceiving. The correlation of inspecting with movements (especially movements of the eyes)—a correlation alleged by several experimental writers—was not confirmed; but evidence was found that memorial and imaginational objects (images) go with ocular movements if and when like *perceived* objects in a like setting call for scanning and scrutinizing movements of the eyes. The second specific point is that many generalized image-objects appeared which were detached from any special setting or imagined occasion and which, therefore, lent themselves readily to the remoter and more abstractive uses of comprehending and thinking. The description of these detached and ready-to-use image-objects in their original setting is a necessary prelude, therefore, to our long-term advance toward thinking.

The next major undertaking was an examination and experimental test of the principles of *Gestalt*, a proposal then on the rise and especially esteemed by us for its corrective effect upon the principle of parallelism. Its emphasis upon functional unities and totalities also promised to exert a constructive influence upon our own envisagement of the psychological field.

After a long and informing discussion in the Laboratory with Professor Koffka, we resorted to experimentation. Since the adherents to the doctrine of *Gestalt* lay great store by the alleged phi-phenomenon and the experiments on visually apprehended movements done by Wertheimer, Koffka, Kenkel, Korte and others, we instituted researches of the same sort. The first[12] was directed toward a factual review of the evidences for phi, which had been described as a *Gesammterlebnis* not factorable into sensational parts, an undivided psychic act. Beyond confirming and re-

[12] G. D. Higginson, The visual apprehension of movement under successive retinal excitations, this JOURNAL, 37, 1926, 63-115.

fining many earlier descriptions of 'artificial' movement (*i.e.* perceived movement from discrete, successive, non-moving objects), the experiments showed (i) the impropriety of dissolving perceived objects into 'sensational' components, the structuralistic fallacy, except for physiological purposes, (ii) the inadequacy of the cerebral mechanisms set up by the configurationists, (iii) the possibility of perceiving movement with objects presented simultaneously,[13] and (iv) the importance of non-visual factors in stroboscopic perception. The whole group of phenomena studied seemed to us, in the light of our results, to fall (quite without the espousal of any theory or doctrine) under the head of perceptive functioning and of the bodily conditions realized in the fairly peculiar circumstances of fixed retinal excitations leading to movement. We found no reason for invoking sensations, meaning, a psychic *Gestalt* or the hypothesis of a cerebral *Gesammtprozess*.[14]

Our second invasion of the configurationist's territory led us to the alleged influence of a total object upon brightness. The champions of *Gestalt* had maintained that a gray was lighter or darker according as it was within or without a configured whole. A black with gray areas within it and adjacent to it was the stock example (Benary). Our own experiments,[15] which were more methodical, extensive and critically assessed than Benary's, tended to show (i) a cardinal confusion between *Grund* and background and between *Figur* (or *Gestalt*) and the draughtsman's design (figure) drawn on paper, and (ii) an exaggeration of the alleged influences of configuration. In sum, we found "the hypotheses of configuration and inherence to be neither clear, consistent nor adequate."

A second research into the same problem was undertaken. Now retinal conditions were more carefully set by way of light-energy, mass, color and contour, visual fixation, exposure and adaptation. Again, the antecedents of perceptive function, as well as the observer's reports, were more meticulously controlled. Finally, the experimenter was specifically primed

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[13] R. F. McConnell, Visual movement under simultaneous excitations with initial and terminal overlap, *J. Exper. Psychol.*, 10, 1927, 227-246.

[14] Little support has been found for the 'gray flash' (proposed from the Cornell Laboratory in its structuralistic phase), said to be the 'sensational' (process) equivalent of the seen movement. The important reference is F. L. Dimmick, An experimental study of visual movement and the phi-phenomenon, this JOURNAL, 31, 1920, 317-332. A later experimental study which used colored lights (G. D. Higginson, Apparent visual movement and *Gestalt*, *J. Exper. Psychol.*, 9, 1926, 228-252), made the 'gray flash' still more untenable. It also made it appear that the central physiology of Koffka and Köhler was an inadequate explanation of at least nine descriptive facts (239) which had emerged from all the experiments.

[15] W. H. Mikesell and M. Bentley, Configuration and brightness contrast, *J. Exper. Psychol.*, 13, 1930, 1-23.

by all the previous studies and clashing interpretations. Jenkins now adds new testimony to the influence of *objects as perceived* upon such items as color and gray.[16] In general, the influence is in the direction indicated by Benary, Gelb, Rubin, and other configurationists. Upon examining the concept of inherence (*Zugehörigkeit*), however, the study seemed to imply that the 'excluded' gray patch is actually more vigorously inspected than the 'inhering' gray and therefore more highly figured. It appears that, as objects-perceived, figure and background (not *Figur* and *Grund*, in the sense of *Gestalt*) are differently qualified (probably by cerebral conditions) and this qualification *slightly* modifies, but does not replace, the normal (retinal?) effects of contrast.

At the close of this study, the nature and bodily conditions of perceptive apprehension were very much better known than they were at the time (1912) when Wertheimer picked up the relatively old problem of movement from resting objects and revitalized it by his vigorous protest against sensationalism. While we found, in the course of these researches, no reason for appealing to the principle of the *Gestalt*, we decided at their end that the configurationists had greatly strengthened the psychologist's command of the apprehensive functions.

All those who attack the problem of the perception of movement to describe and explain this variety of apprehending will profit from Neff's[17] tabulation (34-36) of some twenty conditions underlying the operation and his list of 'mental existencies' and 'mental activities' appealed to by a dozen of the foremost investigators in this difficult field.

At this stage in our investigations the author sought a general clarification of the concepts of *psychological performance* and of *functional issue or product*. He had in 1925 reviewed 'the psychologies called structural,' which he regarded as belonging to "a closed chapter in psychological history," and he proposed a study of the "unitary organism, described in part in experiential and in part in bodily terms," a functioning psycho-

[16] J. G. Jenkins, Perceptual determinants in plane design, *ibid.*, 13, 1930, 24-46.

[17] An extensive review and critical assessment of a century's work on the perception of movement-objects are recorded in W. S. Neff, A critical estimation of the visual apprehension of movement, this JOURNAL, 48, 1936, 1-42. R. S. Woodworth seeks (this JOURNAL, 39, 1927, 62-69) "to glorify stimulus and response psychology," thereby limiting the range of *Gestalt*. What he really seeks is a description (in terms of sensations, perceptions, and so on) of temporal order and sequence, which he calls "reaction stages." We too describe "temporal order and sequence" but find no reason for glorifying stimulus as the billiard cue responsible for all the "reaction stages" of the shot. We find in Woodworth's form of behaviorism (i) a confusion of items in the perceived object with stimulus and sensation and (ii) a muddling of neural physiology with "mental events" which are both effects and causes in the course of 'reaction.'

somatic entity, "the concrete creature of our everyday lives."[18] By 1930[19] this transitional view had given way to a functional account which was set into sharp contrast to the biologizing functionalists (deriving partly from William James and represented by Angell and Judd, on the one side, and Watson, on the other). Here the division was between the biological set of organic operations (B-functions) and the psychological (P-functions). Now everything which could be called conscious or mental material, structure, or force was left out of the proposed view. One kind of structure, the living bodily system, was accorded to biology and psychology alike as that which acts or operates.

The concept of experience was abandoned and the psychological functions were made coördinate with the physiological. In rejecting the dialectic between the organism and the world—common to the biological adaptationists and the behaviorists—the concept of the environment was examined and found to be a special case of text and context,[20] unduly emphasizing the importance of stimulating agent, on the one side of psychological fact, and the outside effects of movement, on the other, to the neglect of the intra-organic resources, operations and energies. Beyond the demands of a general envisagement in psychology, it appears that these two varieties of functionalism offered as little aid as structuralism had to the conquest of comprehending, thinking and related 'higher' functions.

Proceeding from the earlier researches and writing, this review of 1930 first laid the basis for the integrated system of psychological functions. It sketched in eleven provisional classes of functional products which issue from the various exercise of the functions. These products were seen to possess the same standing in psychology as the issues of glandular, respiratory, digestive and circulatory processes possess in plant and animal physiology.

After this stock-taking, development took place in two directions; first systematized and critical publications, with the carrying over of our dynasomatic principles to the special psychologies of the child, the animal, the abnormal, and the socially conjoined,[21] and, secondly, laboratory

[18] M. Bentley, The psychologies called "structural": Historical derivation, *Psychologies of 1925*, 1926, 383-412.

[19] Bentley, A psychology for psychologists, *Psychologies of 1930*, 1930, 95-114.

[20] Bentley, Environment and context, this JOURNAL, 39, 1927, 54-61. Environmentalism seems to have been rooted in biology by Lamarck and in psychology by Herbert Spencer.

[21] Represented by Bentley, *The New Field of Psychology*, 1934, The psychologist's use of neurology, this JOURNAL, 49, 1937, 233-264, The nature and uses of experiment in psychology, *ibid.*, 50, 1937, 452-469, Mind, body and soul in medical

studies upon the functions, their underlying bodily resources, and their government.

The first line of investigation calls for no comment here, save the remark that these consolidating and critical studies seasoned the notion of a distinctive class of organic activities and extended the basal principles of function, government, and bodily agent to the special fields of psychology. This extension brought together under one point of view and one set of working principles the entire subject, excepting only the applications, where, as it appears, certain psychologists have carried into foreign and non-psychological domains procedures (chiefly statistical) and professional training which have been useful in solving many problems confronting business, industry, vocational selection, the training of teachers, and so on.

Here we should speak rather of applications of psychology than of applied psychology, noting that the psychology applied is still meager and, on the whole, fairly old and trite. The psychologist, however, has come to occupy an important place in application, both as directing and strategical officer and as man-in-the-ranks, methodically doing tests and scouting in the field with questionary and notebook. Here is an interesting analogy to the organized and disciplined army sent to relieve flood-sufferers or the strike-stricken industrial city.

In the child, the animal, the defective, the disordered, the socialized, and the institutionalized, on the other hand, the psychologist finds a primary task of description and understanding. Our first attempt here has sought to disengage the psychological problem from the educational, the practical, the biological, the medical, the sociological, and the economic. As we have proceeded, we have been called upon to test our own conceptions against those of the behaviorist, the mentalist, the configurationist, the practical tester, the operationist, and the psychoanalyst. Alliance and workable compromise have supplied a fixed self-instruction, always checked, however, by the demands of psychological coherence and consistency. In this region, most of the program lies in the future, although we have laid out a descriptive account of development throughout the life-course, sketched the outlines of animal and of socialized behavior, and suggested a psychology of the disorders unmixed with medicine, mental hygiene, psychoanalysis or philosophy.

It is especially in the summary of recent laboratory studies (the second direction of our review) that this historical account is designed to lead on to the six researches which follow.

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psychology, *ibid.*, 45, 1933, 577-591, General and experimental psychology (in *The Problem of Mental Disorder*, 1934, 275-308); W. S. Neff, A critical investigation of the visual apprehension of movement, this JOURNAL, 48, 1936, 1-42; J. M. Hunt, Psychological loss in paretics and schizophrenics, *ibid.*, 47, 1935, 458-463, Psychological government and the high variability of schizophrenic patients, *ibid.*, 48, 1936, 64-81; M. L. Lemmon, What is social psychology? *ibid.*, 48, 1936, 665-673; H. W. Wright, Social significance, *ibid.*, 49, 1937, 49-57; C. M. White, The categories of substance, cause and function in Freud's psychology, *Psychol. Rev.*, 39, 1932, 203-224, and Behaviorism, psychoanalysis, and the psychology of the P-function, this JOURNAL, 44, 1932, 263-274.

We consider first investigations into the apprehensional modes of *perceiving, remembering,* and *imagining,* and the executive function of *acting.* Since a relatively large body of knowledge upon these activities has been collecting since Wundt wrote his pioneering *Sinneswahrnehmung* (1862), Helmholtz his magnificent monograph on *Tonempfindungen* (1863), and G. H. Schneider his brilliant *Menschliche Wille* (1882), our intent was less the turning of new soil than the close examination of these operations as members of the whole functional family and especially their relations to the complexer performances of man, notably to understanding, emoving and thinking.

First we consider as sequels to the Rogers, Clark, and Higginson studies in perceiving, the researches of Anderson, Hunt, Freeman, Drury, Glanville, Moul, Gundlach and Varon.

Anderson attacked 'observing' both because that operation, common to scientific method and everyday scrutiny, is based upon perceiving and because it offers an opportunity to examine functional antecedents and the 'adoption of an attitude' toward the thing to be observed.[22] Film colors and tonal-objects were 'observed.' Six different attitudes, or ways of observing, and corresponding accounts of the thing observed were discovered, distinguished by report, and described. Since all of these 'ways of observing' appear under the same stimulus-conditions and the same formal instruction, it is obviously foolish to regard the reporter's account of the thing observed simply as a 'response to a stimulus.' Secondly, it came out that *O* did not, under a fixed command to observe in any one of the six ways, succeed in maintaining a single attitude throughout a given observation. Instead, a host of occasional and self-instructions came in to shift toward other attitudes. In other words, observing is determined more by the organism at large and by the occasion or situation built up at the moment than by the pattern of physical energies (stimulus) applied to visual, auditory or other receptors. Finally, it appeared that inspecting, comprehending and remembering were intimately fused with perceiving in this common and important occupation of human beings.[23]

A second study (Hunt) was undertaken to drill still more deeply into the processes of observing.[24] Here we attempted a description of the entire functional course, factoring the process directly in terms of the psychologi-

[22] O. D. Anderson, An experimental study of observational attitudes, this JOURNAL, 42, 1930, 345-369.

[23] The trite notion of observing to be found in logics of science obviously needs careful revision on the basis of psychological experiment. It is conceivable that such studies might end the age-long contention over the relation of 'fact' to 'theory.'

[24] J. M. Hunt, A functional study of observation, *ibid.,* 47, 1935, 1-39.

cal functional moments found and working backward (as the physiologist typically does) from product to process. Especially were we eager to discover the exact implication of searching, inspecting and comprehending. More complex material (pictures of more or less subtle significance) and also very simple materials were used, task and occasion were carefully controlled, and the period of observing was widely varied. Temporal fractionation into three periods was employed. The results were very rich. They greatly increased our knowledge of functional mode, means of initiation, government and outcome. The two basal means chiefly employed were perceiving and inspecting, with many intergradient and mediating forms. Perceiving was chiefly governed by stimulus and occasion; inspecting (which often involved goal-searching) by the organism at large. Perceiving and inspecting often led the way to comprehending, which yielded its own peculiar products (remote implications, relationships, and the formation or remodeling of the topic). The research led us to revise our notion of searching, which now appeared as a 'generalized function' usually fusing with one or both of the basal modes of operation and widely serving to sustain a task and to give direction and continuity to the active organism. Its obvious relation to associative formations and to acting set special problems for special treatment.

We have seen that even where, as in observing, external energies supply a kind of guide to the organism, the proper activities of the organism itself must be taken abundantly into account. All the more must we look there when 'associative trains'—as in the recital of memorized nonsense series—run their course. Here the theorist has either proposed an associative force or the operation of outside mechanisms (attention, *Hilfen,* intent, reproductive tendencies or sheer contiguity). It would be more in line with our own point of view, however, to regard both associative formation and free recital as instances of functional performance where the only agency or doer was the body.

We next turned toward these 'associational' problems for enlightenment upon the actual operations where stimulus is much less in evidence and somatic processes more.[25] Upon finding that experiment had commonly regarded nonsense-syllables as discrete materials to be somehow strung or 'bonded' together and serially 'reproduced,' we examined the *context* to supply filling and functional organization. By supplying one kind of context after another and discovering by expert report what the actual course of associative events was, we discovered a number of extrinsic contexts

[25] G. L. Freeman, The rôle of context in associative formation, *ibid.*, 42, 1930, 173-212.

(*e.g.* rhythm, melody, spatial placing) and many intrinsic contexts (*e.g.* letter-pattern, rhyme, order of syllables) which entered into the functional pattern. The clue to these contexts was the setting up of accessory operations (rhythmical and melodic forms, spatial and temporal order, vocal mouthings, and what not), which were woven into the 'nonsensical' letters and syllables and so established an integrated train of perceiving, inspecting, anticipative imagining and reverberative remembering, all under the task (self and occasional instruction) of consolidating the literal objects. Again, a total operation which is akin to simple acting but based upon a different sort of antecedent task and leading to a different outcome. The successive trials are much less invariable repetitions (as commonly held) than identical presentations which suggest a variety of accessory constructions from trial to trial. If Freeman's conclusion that 'nonsense' association occurs *only* through the integration of these accessory trains is sustained, we shall have gone a long way from the dry formula of a serial order of stimulus-words and verbal responses 'associatively' connected. Our most illuminating outcome was the discovery of a long functional train (similar to acting) which is almost wholly integrated from the organism itself, the central nervous system being the chief resource.

Although we had now gone well beyond our general rallying center, perception, we found that fundamental operation so useful a *point de repère* that we decided to return to it for further help. We wished (i) to watch perceiving grow from a very small beginning and with slender resources, and we wanted (ii) to examine those abstractive and phantom-like perceivings which we had found (Rogers) useful for comprehending and thinking.

The first inquiry used a kind of nonsense-object made with three nearlying lines.[26] One of these line-groups (having never been observed by *O*) was flashed on a quadrant of one retina either 10°, 20°, or 22° distant from the fovea. *O* drew whatever was seen at the time of the flash in the peripheral field. He then reported verbally. Twelve different line-groups irregularly impressed light-energy in patterns upon areas in all four retinal quadrants. The impresses were repeated until a given observed figure was stable and practically unvaried. At first the function was vague, indeterminate, labile, uncertain, and with little issue. Gradually came hints of line-members, spatial orientation, and internal relations. Through gains, losses, lapses and uncertainties there finally emerged a stable and prompt

[26] M. B. Drury, Progressive changes in non-foveal perception of line patterns, *ibid.*, 45, 1933, 628-646.

operation which brought a highly invariable object representing more or less adequately the presented figure. If we omit the preparatory and reporting phases, we have here, under constant receptoral and instructional condition, the changes which a very simple perceptive function undergoes from moment to moment and from day to day.

Another study of simple perceivings under slender resources used the horopter and called for single or double objects as seen in binocular vision.[27] Instead of exemplifying the 'laws of double vision from non-corresponding areas,' we produced under exacting conditions of perception many inadequate and variable objects. The outcome showed that, where the function operates vaguely and uncertainly, self-instruction does more to determine the product than do the outside conditions, even the retinal disparities of place which have been alleged to lead to double objects ('double images') in binocular vision.

As for the abstractive perceivings we used 'empty' color and sound spaces (Moul), obscure tonal qualifications (Gundlach), and ambiguous vocal fragments (Varon).

Moul's *O*s stared into an uncontoured colored field which was practically homogeneous and without boundaries; again they observed a widely diffused and unlocalized tone or noise.[28] A 'thickness' common to both was reported and described. Here we had a still more 'disembodied' perceiving, practically uncontaminated through its middle course by inspecting or any other function and turning out an unformed, unpartitioned, unshaped, and amorphous product.

Gundlach's *O*s similarly observed binaurally a sound-object produced from a common source and so delivered to the two ears as to present a difference in phase.[29] These sounds were presented in pairs, one following the other. *O* reported in turn upon likeness or difference (in the pair) of volume, brightness and intensity as abstractive characteristics of the sound-objects. The observation, which included inspective search as well as perceiving, also involved a puzzling kind of comprehending which flowed from the difficult task to identify-and-compare one moment or another in the two sounds. The functional resources available, together with the obscure character of the abstractive task (especially volume and brightness), drove the organism to a limit of performance which was very

[27] A. D. Glanville, The psychological significance of the horopter, *ibid.*, 45, 1933, 592-627.

[28] E. R. Moul, An experimental study of visual and auditory 'thickness,' *ibid.*, 42, 1930, 544-560.

[29] R. Gundlach and M. Bentley, The dependence of tonal attributes upon phase, *ibid.*, 42, 1930, 519-543.

instructive to watch. It was like thinking in algebraical symbols that are obscurely known to the thinker. Incidentally we found tonal brightness to be the only characteristic of tonal objects which definitely changes with those conditions induced in the brain by two acoustical excitations unlike in phase at the two ears.

Varon's experiments sought a verification of Sapir's claim that certain speech elements (vocalic and consonantal) possess an immediate 'phonetic' symbolism quite apart from linguistic use and association (*e.g.* ă is alleged to be 'larger' than ĭ).[30] While our study showed that *O*s forced to decide upon the comparative 'largeness' of a-sounds and i-sounds found the a-sound more often 'large,' we detected no symbolism of a linguistic character but only abstractive and attributive aspects (brightness and volume) which we carried down to simple tones and elemental noises.

Apart from the various specific problems which these three studies centrally attacked, we derived from them a fair amount of new knowledge upon the more fundamental functions and the manner in which perceiving and inspecting turn out detached quality-objects which richly supply materials for the more highly derived operations.

Contemporary with some of these studies was a major undertaking (Bulbrook) which sought to reduce the concept of 'insight,' then current in animal and human psychologies, to terms of actual performance.[31] This concept has been most frequently used in theories of learning to denote a rapid 'intuitional' form not resolvable either into sensory processes or into blundering and pedestrian trial-and-error. At that time the notion of insight fitted easily into the doctrine of configuration and became a fellow of 'total-activity' and 'purpose.' Nevertheless we found it decidedly ambiguous and flanked with many synonyms and explanatory epithets; *e.g.* perceptive apprehension, acute observation, understanding, foresight, forethought, rapid learning, intuitive flash, sudden grasp or illumination, intelligence, sophisticated skill, cognized relations, the felt basis of an attitude, experienced determination, new perception of a goal, and new configuration. By taking to the laboratory many instances which had been alleged to contain 'insight,' we hoped to find (if it existed) some common denominator which would submit to an empirical description.[32]

[30] M. Bentley and E. J. Varon, An accessory study of 'phonetic symbolism,' *ibid.*, 45, 1933, 76-86.

[31] M. E. Bulbrook, An experimental inquiry into the existence and nature of insight, this JOURNAL, 44, 1932, 409-453.

[32] "It would seem now to be of less importance to *infer* insight from behavior ('insight' taken, for example, in one of the above senses) than *to obtain a descriptive account of the actual modes of organic performance* where insight has already been alleged," Bulbrook, *op. cit.*, 410-411.

Whereas most serious studies had observed the behavior of children, other primates, and rats and had pronounced it insightful in various problem-solving and maze-running performances, we primarily depended upon the careful reports of trained psychologists and made a primary point of discovering antecedents in the various forms of instruction. Untrained adults and small groups (110 university students in groups of 5-8) were also employed as checks and controls. The thirteen occasions designed to tempt 'insight' included manipulable puzzling objects and designs, detached words to be integrated into sentences, and incomplete numbers and poetic selections. While we found no single kind of behavior which could sensibly be called 'insight' (unless one were content to apply that term to any sudden turn in gross performance), we did find (i) perceiving leading on to action, (ii) perceiving with a valuating imagining, (iii) anticipative imagining, (iv) searching and inspecting, and (v) various forms of comprehending. We also discovered that, in those solutions loosely referred to as insight, occasional and self-initiating instructions play a much more important rôle than formal instruction plays. But we "found no characteristic process, operation, form of conditioning or mode of discovery which we could with propriety distinguish as 'insight.'" An outcome of extreme importance for our experimental program was the discovery that we could carry through, *on the basis of trained individual observation,* and usefully interpret, group-observations of the same order. Thus we replaced the casual watching of a group and the common class-questionary (sometimes called experiments)[33] by a procedure based upon the outcome of technical reports derived from trained observing-experimenters.

An excursion into the field of the psychophysical measurement methods confirmed our suspicion that the traditional 'judgment' of presence or absence, of likeness or difference, could readily and usefully be translated (provided the 'judging' organism is as carefully controlled as the 'stimuli' are) into terms of psychological function and government. In his examination of the distribution of 'presence' and 'absence' reports under very weak (near-liminal) tonal energies, Freiberg found that perceiving suffices the organism where the task is simple and its solution prompt, but that searching and inspecting otherwise enter into careful observation and strongly determine the reported product.[34]

[33] Bentley, The nature and uses of experiment in psychology, this JOURNAL, 50, 1937, 453-455. For a liberal interpretation of the method of experimentation as the 'laboratory' method, compare G. Murphy, L. B. Murphy and T. M. Newcomb, *Experimental Social Psychology,* 1937, 10-15, *et passim.*

[34] A. D. Freiberg, Fluctuations of attention with weak auditory stimuli: A study in perceiving, this JOURNAL, 49, 1937, 173-197. *Cf.* Anderson, footnote 22, above.

This review has abundantly exemplified our purpose to make an orderly descriptive arrangement of one-half—the psychologist's half—of all the fundamental operations of the living organism, and first at the primate level of man. Since the physiologist's task is more advanced and withal much easier (it deals observationally with space-filling and more or less enduring objects and processes), we have followed its methodological lead, regarding the body as the only agent and centering the quest in activities and operations of this common physical system. At the same time, we have not confused the problems of physiologist and psychologist, since they are concerned with different sets of activities, the physiologist (or neurologist or endocrinologist) discreetly *borrowing* when he touches upon the psychologist's functions and the psychologist discreetly *borrowing* in the opposite direction.

We started from the fixed and traditional belief in an ultimate separation of two polar functions, perceiving and thinking; but we soon found intermediating forms. Since perceiving and closely related functions are better known and more easily lend themselves to experimental methods, we first emphasized them in our program but always reached out toward the more distant and more complicated. At the beginning of the year 1935-36, we were ready to review and to extend definitely toward the region of comprehending. which was still an uncharted land for the psychologist.[35] One major research was therefore set to consolidate our gains in the apprehensive group (Erb) and another to reach into the relatively new territory (Neff).

In the first study, remembering (which was still confused) was made central and set into relation to perceiving, on the one side, and to imagining, on the other. After distinguishing real remembrance (a functional return to the biographical past) from the acquisition of 'memorized' materials and from the ambiguous 'memory image,' Erb found experimental occasions for inducing the organism to remember and then secured and interpreted her expert observers' reports.[36] The first result was that the 'backward reference' was an extension of the temporal coefficients, placings, and orderings already achieved in perceiving and that anticipative imagining (the root of all imagination) springs from the same source. This result inclined us to look upon all three functions as closely related members of an operational group, and this view led to the forma-

[35] The tentative and fragmentary account of this type of operation in the author's *New Field* (1934) bears witness.

[36] M. B. Erb, The memorial forms of apprehension, this JOURNAL, 49, 1937, 343-375.

tion of a cross-reference table[37] of nearly a score of apprehensional sub-forms. The second result of the study which is important in the present context is that many 'memories' are decidedly mixed in origin; *i.e.* into their production also enter verbal comments, flashes (*Bewusstseinslagen*), searching and comprehending. This result, while unexpected, served a useful purpose in acquainting us with the high facilities of the organism for combining many functional modes for a single end. Within the physiological group, a like facility is to be found, *e.g.* in all the processes contributing to digestion or to the control of pulmonary respiration.

Neff, who was anxious to get on to the more complex intellective operations, began by a review of the studies already done in this direction in analytic, behavioral, and configurational psychologies, not overlooking the ambitious researches from Würzburg on the *Gedankenelemente*.[38] He found so little fundamental in principle and adequate in method that he thought it expedient to turn again to the ladder-climbing procedure from the simpler to the more complex. His first essay is from apprehension toward *indication* of the 'symbolic' kind. Remembering Rogers' concrete and abstractive kinds of perceiving, he presented five graded forms of an object, beginning with the wholly concrete (an apple, tree, horse, chair, snake, or book) and ending with an abstract, schematic or geometrical hint of the same object. The objects were visually presented in an irregular order and with many repetitions. Besides getting a much fuller account of Rogers' sub-forms, Neff found that the five instances (from most concrete to most abstract) gradually acquired membership in a coherent series. The end was a complete *orienting process*, which went beyond ordinary perceiving. This orienting operation was akin to some of the instances of Bulbrook which the configurationists had called 'insight.'

Although the five gradations were now oriented into a single set depicting *that thing*, no single member thereof stood for, epitomized, *symbolized* the whole set. To drive toward this goal, the experimenter now presented in a similar way sets of four, each set comprising various aspects of a common theme (*e.g.* Set. 14: a woods-fire, a fireman's hat, a bushy clump of stems, and three wavy vertical lines; Set 6: a ship at sea, an anchor, an outlined sail, and a triangle; Set 8: a dog, a kennel, a quadrupedal silhouette, and a horizontal with two verticals extending downward). With many repetitions, we secured for some of the figures (usually the most abstract and schematic, *i.e.* non-individualized, forms)

[37] Erb, *op. cit.*, 374.

[38] W. S. Neff, Perceiving and symbolizing: An experimental study, this JOURNAL, 49, 1937, 376-418.

a memorial context which included all of the others in the set, and, in a final stage of experimentation, one figure became—not a member of, but—a substitute or surrogate for the set-taken-as-a-whole. The *O*s spoke

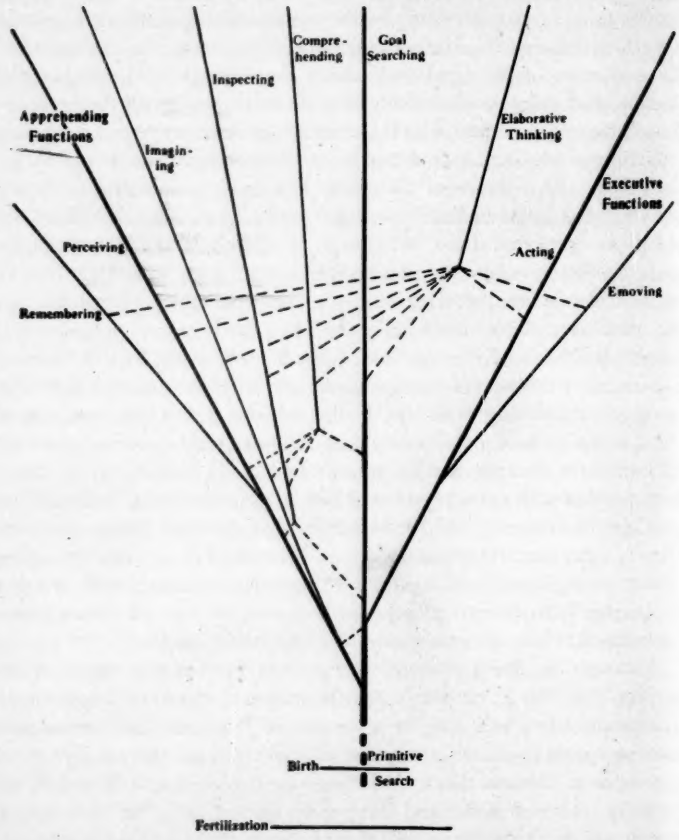

FIG. 1. THE PRIMARY PSYCHOLOGICAL FUNCTIONS

here of a double meaning; (i) 'those lines' and (ii) an indicated class, which had gradually been built up by isolated presentations of each figure in the series. Here, then, *'this* means *that.'* We had passed beyond apprehension to the shadow of some other function which, for the moment, we shall call 'symbolizing,' leaving to subsequent studies the dis-

covering of operations still more remote from apprehension and more fully representative of the realm of understanding and thinking.[39]

At this point we break off the review and go on to the six new studies of the past year. The general sense of the preceding is that—our functional approach decided upon and our experimental methods refined—we have tentatively set into the best available order the fundamental modes, settled our accounts with the leading contemporary psychologies, and carried forward our experimental program. When the studies now to be reported by their respective authors began, we had made the following provisional arrangements of the primary functions set in an order which grossly represents their natural relations and dependences.

Primitive Searching

Perceiving Inspecting Acting

Remembering Imagining

Emoving

Goal Searching

Comprehending Elaborative Thinking

So far as current knowledge of pre-natal and post-natal development of man is able to inform us, the general order of first appearance and of interaction of the primary functions may be tentatively represented by Fig. 1.

Of the whole functional series, the operations best known to psychologists are perceiving and remembering (of the apprehensional group), inspecting, and certain forms of acting. We have now more than an outline of imagining and the beginnings of a psychology of comprehending. At the present moment—and before we can hope for a complete conquest of real thinking—more must be known of the relations and interfusions of acting, perceiving and inspecting, as well as of the functional means by which an object-product of one class makes a symbolizing transition to an object-product of another class. About emotion the psychologist can show little more than a clash of theories and speculations based upon a mass of ancient doctrines and a handful of loose concepts.[40] Goal search-

[39] Reference to Neff's study will reveal other refined functional intermediaries, as well as a review of the historical meanings of the troublesome terms 'symbol' and 'symbolical' (413-414).

[40] Although their descriptive knowledge of emoving itself is extremely meager, the clinical and topographical neurologists are rapidly advancing their account of functional relations of brain-regions, the autonomic apparatus, and the viscera. Since emotion is fancifully taken by them to be 'something subjective' which is 'expressed' by certain body-changes ('expression of emotions'), they are ardently building up a theory of seats and centers. *Cf.* J. W. Papez, The brain considered as an organ; neural systems and central levels of organization, this JOURNAL, 49, 1937, 217-232.

ing is still chiefly hypothesis and inference from gross behavior, while the field of real thinking is scarcely touched by experiment.

Technical terms used in the researches which follow are here given with standardized abbreviations.

act (A)	= acting	verb	= verbal
em (E)	= emoving	fl	= flash
per (P)	= perceiving	SI	= self-instruction
rem (R)	= remembering	OI	= occasional instruction
imag (Im)	= imagining	FI	= formal instruction
insp (In)	= inspecting	P_f	= functional product
comp (C)	= comprehending	G_e	= extra-organic government
T_e	= elaborative thinking	G_o	= organic government
S	= searching	G_h	= historical government
S_p	= primitive searching	[ ]	encloses experimenter's or
S_g	= goal searching		observer's remarks
som	= somesthetic	( )	encloses functional products
kin	= kinesthetic	.	= complete break in function
vis	= visual	;	= closely related functions
tac	= tactual	*cum*	= concurrent functions
com	= comment (in words)	>	= successive functional phases

Functional moments included in compound performances are written adjectively with a small initial letter placed as subscript to an abbreviated symbol for the main function. Thus, A_p = a perceptive moment in acting; E_m = a memorial moment in emoving. In this context, *imagining* and *inspecting* are distinguished by Im and In. Thus, In_s = inspecting qualified by search.

The articles which immediately follow will bear in order upon (i) the functional origin of body-objects (Werner), (ii) the more advanced and derived forms of the self-object (M. S. Ryan), (iii) the nature of anticipation (Lindner), (iv) the temporal integration of actional trains (Longwell), (v) the description and origin of thought-objects in mathematics (T. A. Ryan), and (vi) thought-solutions based upon the analogy (Lemmon). The first two relate various forms of the self-object to the active organism; the third and fourth build functional approaches toward imagination and action, and the last two enter the thorny field of comprehending and elaborative thinking.[41]

To the exposition of these researches will be added a summarizing commentary and a prefatory note upon the further development of the experimental program.

[41] Anyone familiar with the conduct of departmental researches will understand that, in formulating and directing a series of related studies, logic has always to compromise with the actualities of personnel and equipment.

A DESCRIPTIVE STUDY OF SOMATIC OBJECTS

By HENRY CLAY WERNER, Cornell University

Among the wide variety of objects and events which the organism perceives are to be included the body, its parts, its operations, its states, and its conditions. When the organism is routinely occupied with tasks, plans, skilled movements, and problems, or when it is participating in group-activities, the body is generally neglected as a source of objects, although divers states and conditions of it frequently activate self-instructions. Under many circumstances, however, it is common for the body and its performances to stand out as distinct from other objects. I stub my toe and inspect it to see if there is any damage. I suddenly raise my hand to my brow aware of a slight ache there. I change my position in bed to relieve muscles pushing against a hard mattress. I pick off an insect crawling up my arm and rub the area to make sure that all traces of it are gone. Toward noon I grasp my middle, apprehending there a 'hollow feeling.' General bodily fatigue breaks out and interferes with my work. I loosen my collar, compelled by a constricted and uncomfortable neck. It is unnecessary to enumerate further examples. Ocular, dermal, motor, and many other local resources of the organism variously contribute in making the bodily object thus intimate and peculiar.

Our problem is to investigate the apprehending of somatic objects under certain experimental conditions. Since a visual survey of things tends to commingle body and 'outside' objects, we may well eliminate vision, so far as is possible, and rely upon dermal, kinetic, visceral, and related excitation to serve our apprehending functions. In order to distinguish somatic from other objects, states, and occurrences, we shall bring in, by way of comparison, certain non-somatic products of perceiving as well. While perceiving will be basal to our observations, we shall discover that other functional modes are also involved.

The apparatus (Fig. 1) consisted of a cylinder (bicycle pump) (A) with piston, connecting-rod and cross-piece (B), and a tension-spring (C) to counter-balance the weight of the piston, which was actuated through a compressed air-duct (D) leading from the laboratory pump. To the cross-piece of the connecting-rod was attached a cord (E to G) which extended to various parts of *O*'s body.[1] The compressed air had a collateral outlet through a rubber tube (F) attached to the air-pressure

* Accepted for publication May 1, 1937. This study was directed by Professor Bentley in the Research Laboratory of Psychology, Cornell University.

[1] Contrived with the assistance of Mr. Austin King.

system above the cylinder and piston. By closing this outlet and forcing air against the piston and connecting-rod, a pull was exerted on the cord and the heavy canvas band (G) which it controlled. A constriction (H) in the air-line deflected a very

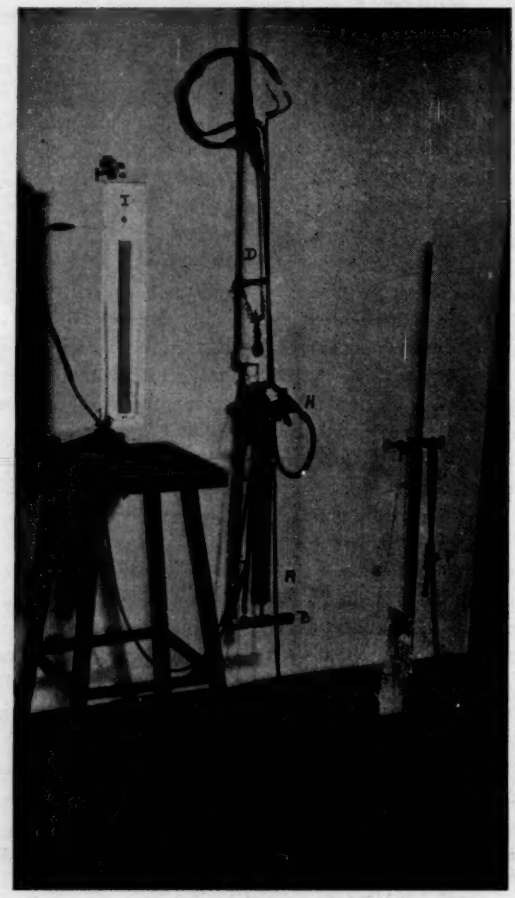

FIG. 1. APPARATUS FOR INDUCING SOMATIC OBJECTS

small part of the volume of air flowing to the piston and actuated a pressure-gauge (I). The gauge was a U-shaped tube, partly filled with mercury and closed at one end. Thus on the closed side of the mercury was a head of atmospheric air and, on the other side, a variable head of pressure, which, by moving the mercury, in-

dicated (in kgm.) the tension on the cord running to G and thus exerting traction on some part or member of the observer. The scale was movable to conform with changes in atmospheric pressure, which altered the zero position of the mercury. The control-tube made possible a gradual pull of the cord, starting from 1 atmosphere (zero pull) and running to a maximal 10 kgm.

O was seated blindfold near the apparatus, with the canvas band loosely in contact with some part of the body surface.[2] The following formal instructions were given.

At the preparatory signal 'Now,' begin to observe and to report in terms of perceptive products. Continue observation until given the signal 'Stop.' Resist all tendencies to bodily displacements.

The band was applied to the following parts of the body, with and without arm- or head-support;[3] lower dorsal and ventral arm, wrist (*O* standing), forehead, upper ventral arm, front and rear neck. Five observational reports were taken for each observer for eleven different attachments of the band. Reporting required 1–15 minutes.

Functional Products

Range and variety of objects and events. The products of perceiving fall into two general classes, somatic and non-somatic. We especially sought richness and variety among the somatic objects.

The *non-somatic* object is usually apprehended as 'doing something' to the body. It is an object or device actively in contact with the arm or other part, slipping, pushing, pulling, tugging, or releasing its hold against the body. Again, it is perceived as pulling the body from a distant source, and also as changing its contours. It is narrow and thin, large and massy, hard or soft. The changes in contour and other characteristics of the non-somatic object will be detailed in later descriptions.

O reports a wide variety of *somatic objects.* These include body-thrown-to-one-side, tense or strained body, relaxed body, constricted artery in the neck, sore throat, bloated face, bent arm, stiff neck, numb hand, painful arm, dry mouth, clammy palm, constricted muscle, 'heavy' head, and strained shoulder.

Frequently the products are *somatic events.* The whole body is working to prevent the arm from moving, the right thigh is pushing firmly against the side of the chair, the wrist is tightening, blood is shooting to the finger tips, shoulders are pulling, muscles of the lower arm are relaxing, head is swelling, Adam's apple is pushing against the esophagus, arm is stretching and pulling out from the arm-pit, elbow and wrist are pulling against one another, skin is moving over the scalp, palm is sweating, neck is shrinking, head is throbbing and blowing up like a balloon, muscles of the arm are sliding over an armbone, head is flattening, skin is pulling away from the arm, or toes are digging into the floor.

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[2] The observers for the experiment were Cleo Chrisof (*Ch*), Laura Allen (*Al*), and Edward Suchman (*Su*), graduate students in psychology.

[3] The purpose of stimulation at many parts of the body was to determine whether *O* would thus apprehend somatic objects of various orders. The results showed that there was no significant difference with and without supports and only minor differences in report among various parts of the body where the band was applied.

Once more, *O* reports at times *general bodily states* which are perceived along with somatic object or event. These states include difficult swallowing or breathing, loss of bodily equilibrium, gross and widespread fatigue, general relaxation, and bodily well-being.

Description of somatic objects. We must here consider the patterning aspects of our functions. Reports of the somatic objects were usually made in terms of isolated quality or condition of the object. The arm, neck, or head is not perceived as a mere part of the body, apprehended at a single moment. Instead, the report is 'a slight pressure of the lower dorsal arm,' 'an intense strain throughout the whole neck,' 'a tingling, cool brow,' 'a rectangular pressure in forehead containing a center of intense pressure surrounded by a lighter, more diffuse pressure,' and 'a slight pain spread from elbow to wrist.' The contour of the somatic object is often ill-defined. We may say in general that the perceiving tends to be abstractive. It is less abstractive, however, for somatic events than for somatic objects; 'the wrist is swelling,' 'the skin is sliding over the scalp,' 'the shoulders are pulling,' and the like.

Bodily conditions when perceived usually lack detail. They are gross, widespread, global 'feels.' It is general bodily ill-being, relaxation, fatigue, or helplessness which *O* reports. Apprehending doubtless depends largely upon proprioceptors and interoceptors, which are famous for producing vague patterns in perceiving. Neural excitations tend to be unsystematically arranged in temporal and spatial orders.

Another characteristic of the apprehending is its constant passage from one somatic object to another. There is a wide panorama of somatic objects, some of which are undergoing qualitative changes. Thus *O* apprehends in succession 'an intense, heavy, aching forearm > tops of shoulder pulling > tense muscles in arm-pit > the whole body resisting > strained stomach muscles > upper arm pulling,' etc., all of which are ligated in the apprehending. Some of these objects hold a unique place in the general pattern. The tensed muscles of the arm-pit take the foreground of great clarity in this pattern (inspecting), while various other somatic objects (the strained stomach muscles and the resisting body) either receive less emphasis or drop out of the perceptive panorama which, on the whole, remains relatively constant. This is explained, in part, by the variety of stimuli attacking the organism's receptors at a single time, as a result of which a large number of objects are perceived. Because of the rapid succession of perceived objects, *O* is unable to report all of them on a single occasion, so he resorts to self-instruction: 'Let me see, here are a number of products. I'll give you as many as I can.' This fact also suggests that few bodily states are reported because they stand obscurely among the perceived objects and are not inspected.

Frequently one quality is singled out from the object for inspection and its particularity reported. Thus 'the light pressure on the dorsal lower arm has greatly increased. It is spreading up the whole arm, and it is now a deep, muscular pressure, rather than cutaneous.' 'The pain in the forehead has now encircled a wider area. It

covers the head and extends down into the muscles of the neck. It is very clear, and predominates over all other perceptions.' Not only is the contour of the somatic object ill-defined, as already mentioned, but the object itself is neglected for a qualitative detail. 'The pressures in ears are like soft balls of cotton, fuzzy on the edges and tending to expand as though about to break.' 'The ache in upper arm is an egg-shaped lump, attached by a fine strand of pressure to another lump in shoulder. This in turn is attached to a lump of ache in the neck.' 'The pain in the front of neck is cone-shaped, the tip of the cone being in the center and the sides spreading out toward the surface.'

A number of conditions determine the clear particularity of object and quality. First, there are the various aspects of the stimulating agent. When this agent is in contact with the skin, exerting no pull, *O* apprehends the non-somatic object and the part of the body to which it is applied. The body surface is slightly pressed. As the agent tightens around the surface, *O* apprehends a moving non-somatic object whose contours are more clearly perceived. Then the somatic object (*e.g.* dorsal arm) is more intensely pressed. More somatic objects are now perceived, 'the body is resisting a pull,' 'shoulder is starting to strain,' 'the neck has a vague, non-localized pressure.' As stimulation gradually increases (or decreases) more somatic objects are apprehended and their qualities undergo changes. The intensity of the stimulating agent is thus of prime importance in determining the character of the somatic objects.

Of lesser importance is the place of application. If the non-somatic object is perceived as tightening around the neck and is comprehended as about to interfere seriously with such a vital bodily function as breathing, the constricted neck is more focal, say, than the tense neck-muscles, the clenched jaws, or the pulling shoulders.

Then there is the durational aspect of the stimulating agent. When the band exerted a strong pull on the body and when the body musculature was actively straining to resist it, *O* at times apprehended the non-somatic object, inspected it to discover what was happening outside the body, and anticipated that if the pull lasted much longer, he would be unable to maintain his stand against it. The duration of the pull from the 'outside' object directed *O*'s perceiving from somatic to non-somatic object. Again, if the strain in arm-muscles caused by the stimulating agent persisted for some time, 'fatigue of the whole arm' would replace 'strained muscles.'

Besides these properties of the stimulating agent, such varied factors as task, instruction, and current functional trends change the status of somatic objects in the perceptive panorama. We shall consider these three conditions together. Formal instruction required report on perceptive products. This implies a searching which leads to the apprehension of 'new' somatic objects, with the result that these objects take the foreground at the moment. Again, when bodily movement is difficult to eliminate, the working-body receives the emphasis. Self-instruction directs *O* to a particular somatic object, while occasional instruction throughout the course of apprehending is causing first one object and then another to be singled out from the rest. If *O* is inspecting the pressure-area on the head, for example, strained neck-muscles and the tense body may be momentarily neglected.

Upon all these widely varied factors depends the status of the somatic object.

It might be inferred from certain observational reports stressing a single quality or aspect that we are dealing with 'sensations.' Indeed, there are here indications that *O* sometimes reports in part in a sensationalistic context. Thus 'the pressure has turned into a dull ache which is spread over a wide territory from a vague ache

in neck to a more intense ache in arm and a continuous ache in shoulder;' 'the strain in upper arm is greater than that in lower arm: kinesthetic pressure has replaced cutaneous pressure;' 'now a gagging sensation,' 'the pain is very intense.' What is really perceived, however, as the reports on other occasions show, is some bodily part undergoing qualitative change. It is always an aching neck, arm, or shoulder that has replaced a strained arm; a pressure of the arm-muscles where before it was of the skin; a constriction of the neck interfering with breathing, or intensely painful neck-muscles. Were it merely ache, pressure, gag, or pain unreferred to the body, and quite isolated as a quality, then we should be in the realm of the structuralist's 'sensations.' But since the aches, pressures, pains, and the like are all qualitative descriptions of the somatic object, they have no rôle as 'sensations.' This fact eliminates the possibility of resort to mental agencies or processes in our description.

Then how does the organism distinguish somatic objects and somatic events from others? Merely by reference. The somatic object is referred to the body, its states, or its conditions. It is just this reference that determines its status as a body-object. The 'external' object, on the other hand, has a relation (not a reference) to the body. It is a band that is 'doing' something to the body, touching a body-part, pulling or slipping away. This reference of object to body and non-body will be further discussed when we describe the non-somatic object. Here we may say it is by point of reference in apprehending that we are able to differentiate kinds of objects, just as it is by reference that we are able to apprehend objects and events as past, present, or future.

Description of non-somatic objects. The non-somatic objects apprehended include the stimulating agent, head and arm supports, and floor. Since the latter three are perceived only when the body is actively resisting the pull of the band ('head pushing against rest,' 'hand clasping support to withstand moving arm,' 'toes digging into floor'), they need not concern us.

The contours of the band, however, frequently change. On the arm and neck, before the band pulls, the contour is rectangular or U-shaped as a soft, non-somatic object with ill-defined limits. The contour is often uneven, the object is perceived as at the sides, not in the center of the arm. On the head, 'a long, narrow object is in contact with the skin; the contour is rectangular with fuzzy ends.' As a pull is exerted by the band, the non-somatic object is perceived as round and hard. One *O* reports it as 'contracting like a rubber band.' As it comes in firmer contact with the skin, the object takes a narrower contour. *O* frequently reports it as 'completely encircling the arm or neck, extending out from the body and crossing.' The dimensions change. 'There is a mass pulling on my arm;' 'the object has rolled up and is a narrow, thick wad against my arm;' 'the object feels like the back of a knife-blade pressing into my forehead.' Upon release of pull, the non-somatic object is perceived as 'expanding and flattening out, regaining its former two dimensions.' It becomes again 'a soft, smooth object with vague contour and ill-defined limits.' There are also

changes in position. 'The object is slanting from the right top of forehead diagonally across left eye;' 'the external object on front of neck has changed its position and is now under chin.'

In addition to its contour, the non-somatic object is perceived as pulling the body. 'The object is tugging behind on both sides of neck;' 'the band is moving across the surface of arm.' The pull is not always from a non-somatic object in contact with body, but may be from a distant object. This perception of a distant 'external' object pulling the body is reported by all *O*s. Occasionally the reference is ambiguous. Thus one *O* reports that the body may be pulling against this distant non-somatic object or the object may be pulling the body. At high bodily tension, all perception of the pulling non-somatic object is lost. The reference is then exclusively to the body.[4]

This shift in reference from non-somatic to somatic object, when the non-somatic object can no longer be perceived, occurred in a majority of the reports. The somatic objects hold the perceptive field, although usually one somatic object, 'aching arm,' 'strained shoulder,' 'resisting body,' 'throbbing head,' 'stiff neck-muscles,' 'Adam's apple pushed against esophagus,' has the greater clarity. The non-somatic object is reported as having disappeared when self-instruction directs *O* to inspect it. This was accompanied by the comment: 'I no longer perceive the non-somatic object, even when I search for it.' Any bodily movement or sudden movement of the stimulating agent, however, causes the non-somatic object to reappear; but upon release of pull, bodily relaxation becomes the main somatic event. This is often followed by the perception of a swelling arm, neck or head, which in turn receives the greater emphasis.

The blotting out of the non-somatic object from the perceived field occurred in all positions of the body at which the stimulating agent was applied. The measurement of the amount of pull (kgm.), when the non-somatic object was reported as no longer apprehended, indicated that its first disappearance from the perceptive field occurred at a fairly constant figure. Thus in one position the amount of pull exerted by the stimulating agent when the non-somatic object was no longer perceived ranged from 1.8 to 2.7 kgm. for all *O*s.

Here, then, is another illustration of the difference between the perception of somatic and non-somatic objects, under our experimental conditions. Unless the 'external' object is perceived in some relation to the body, it is no longer apprehended as non-somatic.

Functional Modes Employed

We have already implied that several of the psychological functions are involved in creating objects and events of the somatic kind. Here we must investigate these functions to determine where and how they appear and what rôles they play.

[4] A similar instance in the perception of weight has been reported by Ponzo and Angyal, who had *O*, tightly blindfolded, grip a mug resting on a support. The support was then removed and, as long as the weight of the object was not too great, *O* could not tell whether the mug rested upon a support or not. (*Cf.* M. Ponzo and A. Angyal, Zur Systematik der Gewichtsempfindungen, *Arch. f. d. ges. Psychol.*, 88, 1933, 634.)

First we shall consider the apprehending functions. Whenever the organism lays hold of objects and events—whether somatic or not—as present, it is perceiving. The 'bent elbow,' 'strained arm,' 'pulling shoulders,' and other somatic objects are products of *perceiving*. Perceptive events are also common in the reports: 'my hand is going to sleep,' 'the painful elbow is very clear,' 'my whole body is resisting a pull,' 'the neck muscles are slightly strained.' Were these same objects and events apprehended as past, the apprehending would be of the memorial form. So far as we can determine, however, *remembering* was never used in creating somatic objects and events. Perceiving is basal, of course, in our experimental setting and under our formal and occasional instructions. This patterned function we found to be chiefly dependent for initial support upon tactual, kinaesthetic, visceral, and related receptoral excitations.

Now 'somatic' apprehending is sometimes extended to include future phases. An *imaginational anticipating*, which does not destroy the perceived products, brings out such things as 'non-somatic object will soon start to tighten on the arm,' 'relaxation is about to follow,' 'the body will be straining shortly,' and the like; *i.e.* the apprehended product is about to undergo change.

Anticipation also adds an intermediate *searching* for something undefined and unformed in imagining. Thus *O* reports that 'something is about to happen to the body' or 'this pull won't persist much longer.' This is not quite 'primitive search,' for the anticipating is based upon a definite perceptive product. It tends forward (sometimes inspectively) toward the about-to-be.

But, again, search may be more than a vague anticipating. It is often a hunting or exploring which is clearly inspective; *e.g.* 'looking for new things to report' and 'that pull must be from a distant source.' These mark an endeavor to discover a specific object or a definite end by way of a forward-searching inspection.

Inspecting is also confined to the perceptive field where it serves to give a fuller and richer description. Integrated with perceiving, it enables *O* to obtain a completer account of object or event; *e.g.* 'the non-somatic object in contact with the forehead has a rectangular shape,' 'the contour is clear except around the edges where the boundaries are ill-defined,' or 'pressure (dorsal arm) is light, vague, and somewhat diffuse.' In these instances, inspecting proceeds from a self-instructed task. Hence the comment, 'I must try to be more discriminating in describing these products.' Wherever perceived objects tend to vagueness, *O* is inclined to inspect for completer information of details, parts, contours, and so on. The non-somatic object is often obscured by a clearer somatic object; but by inspecting, *O* may observe that 'the band is in contact with the sides of the arm, although I do not get it unless I inspect,' 'the skin seems too tight for the head, particularly between the eyes,' 'the pull of the distant object is not as great as previously,' and 'the muscles of the whole neck are now straining.' Inspecting is thus a valuable supplement and extension to perceiving when it is initiated by self- and occasional-instruction.

Once more, inspecting a perceived somatic object frequently leads to the product taking on a significance or meaning beyond itself. The details thus release *comprehending*. The inspected product then becomes obscure and something is signified in place of it. Thus 'the muscles sliding back into position on the arm, the arm relaxing and swelling' signifies that 'the non-somatic object is releasing its pull,' 'the Adam's apple perceived as pushed against the neck' signifies 'that breathing is

threatened,' 'bloated-face-and-throbbing-head' signifies 'an artery in the neck constricted,' 'strained neck-muscles' signify 'a stiff neck,' 'whole body straining' signifies 'a pull from a distant source.'

Let us now consider the executive functions, *acting* and *emoving*. We have already implied that searching under a task set by formal instruction ("resist any tendency to move") might easily develop an actional determination which would be resolvable through movement. It did develop when the pull on the band led to the inspective comment "the non-somatic object is beginning to pull." This set the task 'resist that.' The resolution came in a tensing of the body neatly adjusted to resist the increasing pull ('I am straining to resist the pull of the non-somatic object'). A complementary form of this acting followed the gradual release in pull of the stimulating agent. Under the selfsame formal instructions, *O* now resolved the action in a contrary way ('this pull will not persist much longer' or 'relaxation will follow shortly'). The determination ended when the non-somatic object had released its pull, the straining muscles thereupon relaxing. These actions thus consisted of the three phases; task-setting under formal instruction, course of determination, and resolution through neuro-muscular adjustments and (at times) overt movements.[5]

A related form of emoving, closely resembling the action which we have described, occurred several times. When *O* was actively resisting a very strong pull from the stimulating agent, he sometimes got the non-somatic object as 'cutting into the forehead, as paining neck muscles, and as generally straining the body.' From this situation came a predicament. *O* was helpless under heavy demands: ('most uncomfortable . . . wish I could do something . . . hasn't this pull yet reached its limits!'). The actional determination was frustrated by the formal instruction to resist any tendencies to bodily movement. The predicament died out with the release of the non-somatic object ('I hope that I don't have to go through that again . . . : at last relief'). Here we find a typical emoving: the dramatic apprehended situation > seizure (bodily helplessness) > attempts at resolution (to let go, checked by formal instruction) > decline through relaxing of tense muscles.[6]

Elaborative thinking seems not to enter into our descriptions: no thought-task is reported.

Summary and Conclusions

In our study of somatic objects and events the functional products have been described, first, in terms of their various qualities, their contours (often ill-defined), and their concrete and abstractive characters (the somatic events being less abstractive than the corresponding objects and states). Secondly, it was found that the organism distinguishes among somatic objects and events and between somatic and non-somatic objects by point of reference. The non-somatic object is never referred to the body, but is always apprehended in relation to it. When this relation is lost, the object is no longer perceived as non-somatic. The somatic object, on the other hand, is always body. This body-not-body reference depends

[5] *Cf.* M. Bentley, *The New Field of Psychology*, 1934, 210-211.
[6] *Ibid.*, 232-236, 245.

upon a number of factors. Some of these have been found to be properties of the stimulating agent, task set, formal, occasional, and self-instructions, and current trends of the organism.

Finally, the organism was discovered to functionate in the perceiving, imagining, searching, inspecting, comprehending, acting, and emoving modes. Perceiving and imagining fundamentally produce somatic objects and events, an anticipative search adding temporal perspective; inspecting, by extending and modifying the perceiving, enriched the somatic products; comprehending added significance; and acting and emoving added the dynamic and dramatic elements of determination, resolution, and predicament. All of these psychological factors, whether they run isolated courses or appear integrally as complex functions, are to be held accountable for the peculiar and intimate *quale* of the body-object and the body-event.

While the self-object presents, in the course of individual development from infancy onward and especially under socialization, a very great number of forms and qualifications, we have, in the somatic forms of it, here described and referred to their producing functions, a fair representation of its more concrete and more primordial aspects.

AN EXPERIMENTAL APPROACH TO THE SELF-OBJECT

By MARY SHAW RYAN, Cornell University

The term 'self' is used in many different contexts. Epistemologists deal with a 'self' or 'subject' which knows objects. The psychoanalyst and the psychometrician hold somewhat similar notions of a 'self' or 'personality' which is something to be diagnosed, treated, and measured. Psychologists have variously defined the term as 'a sum-total of the experiences of the individual,' as 'a mental matrix of kinesthetic and organic ingredients,' as 'the possessor of faculties and powers,' as 'an aspect of all experiences,' and so on and on.

When we consider critically the many uses of the term, it appears that most, if not all, of them fall under one or the other of two captions; *i.e.* self regarded as *agent* (subject, knower, planner, willer, desirer, performer, etc.), and self regarded as *object* (object perceived, remembered, understood, approved, condemned, and the like). It will be useful to note this distinction in the meaning of the word since a failure to distinguish has often led to confusion and misunderstanding. Before we begin the account of our own experiments, we must make a hurried review of both uses.

Many psychologists assume some sort of active agent, variously called *self, experiencer, individual, organism, ego, person,* and *reactor.* For some, the self or its equivalent is actual while others use it as an abstraction or at least as a substantial being which falls quite outside the realm of description.

Structuralist and behaviorist have generally made a point of ignoring the concept. The first was concerned with an analysis of consciousness in terms of process; the second with an analysis in terms of bodily reaction to physical environment.

For the psychologies of act and of biological adjustment, the self as agent assumed real importance. Conscious acts commonly implied the self as actor, and biological functionalism assumed a psychophysical self with powers of adjustment to the conditions of life.

As for the self regarded as an object, the earlier behaviorists ignored that along with the self-agent. Psychologies of act and of biological service regard the self as object as well as agent. The 'self-object,' however, is for them only of secondary import. For the former, the act which refers to, or 'intends,' the object is the primary concern; while the psychologists of biological adjustment emphasize adaptive value rather than psychological product. The psychologists of 'content' ordinarily analyze the self-object into organic, kinesthetic, and other elementary processes.

Some who make the self central in their theories include it in every experience. Stern is an example. For him the self means the person who experiences and does.

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He defines person as "eine individuelle, eigenartige Ganzheit, welche zielstrebig wirkt, selbstbezogen und weltoffen ist, lebt und erlebt."[1] The person is the center of a 'personal world' and the substratum for the three modalities of human life, biological, psychological, and social. Psychology, standing midway in this trinity, is the science of the experiencing person, *i.e.* the organism which performs physiologically, psychologically, and socially. Although this person is usually not apprehended, Stern believes that it can be, and, when it is made an object, it is identified with the person-which-performs.

Calkins agrees with Stern that the object-self is the same as the performing self, but she contends that this self is present in *every* experience.[2] For her, consciousness can be analyzed either structure-wise or as an interrelation of conscious selves. Later, however, Calkins had forsaken her 'double standpoint' and the self became her basic notion, implying both agent and object. 'Myself' is 'conscious of' objects and among objects is to be found the personal self. 'Myself' is described as possessing the four properties, relative persistence, complexity, uniqueness, and sustaining a relation to objects (personal and impersonal).[3]

Calkins held that, by considering the self as the basal fact of psychology, structuralism and biological functionalism could be reconciled since the 'self-being-conscious' can be analyzed into the elements of the structuralist and, at the same time, it is related to its environment in an adaptive or beneficial way. This would, of course, be impossible if Calkins had distinguished our two meanings of 'self.' For, in attempting to reconcile her self-psychology with structuralism, she is dealing with the self as object or as 'the experienced,' whereas in reconciling her point of view with the biological functionalists she is discussing the self as agent.

Titchener replied to Calkins that if process-consciousness and self-consciousness can be reduced to the same elements, then the latter must be reducible to the former.[4] He denied that self-consciousness is to be commonly found within experience. McDougall and Lipps agree with Calkins that the self is directly and always to be experienced. The discussion is mainly theoretical.

James discusses the 'empirical' self as an object in psychological performance, or, as he would put it, an 'object in the stream of consciousness.' "In its widest possible sense, however, a man's Self is the sum total of all that he CAN call his."[5] Taken thus widely, the self can be divided into material, social, and spiritual selves and the pure ego.

The *material self* is body, clothes, family, and possessions. There are as many social selves as there are human groups regarding the individual in different ways. Thus a social self is the product of *other* organisms and not of the individual in question. The 'spiritual' self seems to imply a magical agent. It is "a man's inner or subjective being, his psychic faculties or dispositions taken concretely," albeit a

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[1] W. Stern, *Allgemeine Psychologie auf personalistischer Grundlage*, 1935, 98.

[2] M. W. Calkins, *Introduction to Psychology*, 1901; *First Book in Psychology*, 1910; The self in scientific psychology, this JOURNAL, 26, 1915, 495-524; Reconciliation between structural and functional psychology, *Psychol. Rev.*, 13, 1906, 61-81.

[3] *Cf.* J. N. Curtis, On psychology as science of selves, this JOURNAL, 26, 1915, 68-98.

[4] E. B. Titchener's review of Calkins' *Der doppelte Standpunkt in Psychologie*, *Philos. Rev.*, 15, 1906, 93 f.

[5] W. James, *Principles of Psychology*, 1, 1890, 291.

part of it is found—when examined carefully—to consist of certain motions in the head and throat. The 'pure ego' is recognized personal identity through time.

James' selves are the products of psychological performance variously apprehended and conceived. At times, however, a self is an object in consciousness rather than an active agent or magical power.

Koffka has an 'ego' which is both agent and object. This ego is made up of various sub-systems. The core is the 'self' around which the various other sub-systems are organized.[6] The ego is separated from the other objects, but its limits vary from time to time; the body, the clothes, the family, the political party, etc., depending upon conditions.

Experimental investigations. In spite of much writing and many speculations about the self, experiment has been meager. Calkins' four fundamental characteristics and James' constituents, both alleged to be empirical, grew out of uncontrolled observations and were not experimentally verified. We cite a few experimental or half-experimental studies based on, or suggested by, these alleged selves.

Titchener, who disagreed with Calkins' view that we are always conscious of our 'selves,' questioned men trained in psychological observation. Of thirteen colleagues and others he asked the question (quoted from Calkins); " 'I am always inattentively or attentively conscious of myself, whatever the other objects of my consciousness.' Is this statement true, as a matter of experience, (a) in everyday life, (b) in the introspective exercises of the laboratory?"[7] Eleven of the thirteen answered (a) negatively and the other two qualified their statements. Thus he concludes that 'self-consciousness' is, in many cases, an intermittent and even a rare experience. In a second question Titchener asked for a description of the self-object as explicit (*e.g.* 'sensations') or implicit (*i.e.* intrinsic or inherent in the course of performance). Answers were unsatisfactory. The constituents were found to be, in order of their frequency, organic complexes, visual imagination, and affective processes.

Amen also undertook to test Calkins' self. Her purpose was to discover (1) whether there is an immediate, unanalyzable, and observable experience of self (in Calkins' sense); (2) what the attributive terms are which most accurately describe it, and (3) whether it is present in all or only certain experiences.[8] Four *O*s were first shown nonsense-designs of variegated colors and were instructed to choose one for later description. No formal instruction called for a report on the self. Again, with like designs, a comparison was made between choice and recognition. Thirdly, *O*s were asked whether they were 'conscious of themselves' during the experiments and if so when and how. A fourth series involved a choice and also a problem to solve, and a fifth only a problem. Finally, problems were given to a group. Amen concludes that "there is an immediate experience of self observable to introspection, which is analyzable into meaning, imaginal and sensory components, which are,

[6] K. Koffka, *Principles of Gestalt Psychology*, 1935, 341.
[7] E. B. Titchener, A note on the consciousness of self, this JOURNAL, 22, 1911, 542.
[8] E. A. Amen, An experimental study of the self in psychology, *Psychol. Monog.*, 35, 1926, (no. 165), 14.

however, integrated in concrete experience in a unitary existential whole." Calkins' terms were not found to characterize the 'self-experience,' and, moreover, 'consciousness of self' was not found to be present in all experiences.

Experimentation in other subjects has here and there mentioned a self-object but has brought no descriptive evidence. In an experiment on 'personality' L. J. Martin hit incidentally upon a good many examples of self-object. Her *Os* had visual images of themselves at a particular time and occasion. She describes the places and occasions only.[9]

It appears, then, that little descriptive evidence is at hand to support the claims of the self. It is this description that we undertake. We have set out ~~(1) to~~ to collect a large number of 'self-objects,' (2) to classify them as psychological products, (3) to describe their evocation, (4) to relate them term for term with functional modes, and (5) to determine the conditions which govern the organism in apprehending or otherwise giving issue to such objects.

In order to obtain a fair sampling, we have devised occasions which are as nearly as possible like the occasions which might induce them in everyday life.

In Part I we have used words, questions, quotations, handwriting and photographs, and in Part II questions from a typical 'test of personality.'

Part I

Method. Three general kinds of material were visually and orally presented: (1) words (nouns, pronouns, verbs, adjectives, and adverbs), questions, statements, and signatures; (2) possessed and familiar objects; and (3) pictures.

The same four *Os* were used in all series. With one exception, they were ignorant of the nature of the experiment.[10] No theory, doctrine or definition of the 'self' was given to the *Os* and no reference to 'self-objects' was included in formal instructions.

In *Series 1,* fifty words, typed on cards, were presented in succession at a convenient reading distance. The oral instructions were:

Here is a list of words. After each word report as rapidly as you can whatever comes. Continue recitation until I say 'stop.' At this signal report the course of events as they have just occurred.

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[9] L. J. Martin, Personality as revealed by the content of images, *Science,* 45, 1917, 393-399.

[10] Some of the materials used will be found in an appendix (p. 251). The observers were R. M. Lindner (*Li*), T. A. Ryan (*Ry*), M. L. Lemmon (*Le*), and S. G. Longwell (*Lo*), all doctoral students in psychology and all actively engaged in experimental research. Dr. M. B. Erb (*Er*) was added in the first series, and Professor Bentley observed in the preliminary stages of each set of experiments. All *Os* were trained in the art and terminology of functional report. They distinguished, therefore, functional products (self-objects and other objects) from functional activity itself. They recognized, moreover, the various forms of instruction, task, and governmental control.

Exposure time for each word was approximately 10 sec. At the signal 'stop,' *O* gave a full report of the course of his performance, indicating the psychological activities involved and their products.

Included in the list of words were the individual's first and last name, words applying to present position and the like, designed to bring out reference to the observer.

Series 2a (questions) and *2b* (quotations) were given together. The questions were 25, and the quotations 25. The latter were taken from poetry, technical literature, and fiction. Some were familiar to the *O*s and others unknown. Two quotations from published work of each *O* were included. Formal instruction ran:

Here is a question (quotation). When you have sufficiently considered it, signal by tapping on the table. Then report in terms of function and product.

In *Series 3* familiar objects, possessions of our graduate group and articles from the Laboratory were assembled. Each *O* was presented with two of his own possessions. *O*s were also shown some article which each had given *E* as a gift. The experimental room was lightless while *E* posed the object in position for observation. The formal instructions were:

When the light goes on you will see an object. When you have sufficiently considered it, signal by tapping on the table. Then report (into the dictaphone) in terms of function and product.[11]

Series 4 consisted of written signatures. Besides six strange or 'neutral' names, were included signatures of (1) the observer, (2) of the observer's mother, and (3) another member of his family (*Le* and *Ry*) or a close friend (*Li* and *Lo*). The formal instructions ran:

Here is a signature. When you have sufficiently considered it, signal by tapping on the table. Then report in terms of function and product.

Series 5. Thirty small portrait photographs included (1) familiar persons, (2) unfamiliar persons or groups, (3) animals, (4) houses, (5) scenes, and (6) the observer himself. For the pictures of *O* some were from early childhood, others at 12-16 years, and others taken recently. At times *O* was shown alone, and at times with family or friends.

The series was so arranged that *O* was shown a picture of himself after (1) an unfamiliar person, (2) a scene, (3) a familiar person, (4) an animal, or (5) another picture of himself. Instructions were:

Here is a picture. When you have sufficiently considered it, signal by tapping on the table. Then report in terms of function and product.

Series 6. Immediately after each observation of Series 5, *O* and *E* engaged in conversation, which was presently interrupted by *E*. *O* was then instructed to report the course of events and the products from the conversation. As the presentation of the pictures in Series 5 occupied three observation periods, Series 6 consisted of three parts. (1) The conversation was allowed to proceed naturally until the interruption. (2) During the conversation *E* looked at *O* and said "what have you on your face?" After *O* had attempted to find and remove the suspected spot, he was

[11] The dictaphone was used to induce self-reference from the reproduced voice of *O* in a supplementary exercise. The records were not, however, sufficiently clear for the individual's recognition of his own voice.

asked again to report the course of events both during the conversation and the incident. (3) *E* asked *O* to comment on the series of pictures as a whole when the last day's set was finished. When no spontaneous comment was forthcoming it was forced by questioning. Thereupon *E* expressed disbelief in the truth of the forced comment. After *O*'s reply to the contradiction he was again asked to report on the course of performance during the colloquy.

This series was included in order to discover something about the way in which 'self-reference' occurs in a paired congregate.

Series 7. A series of statements primarily designed for reference to the socialized self. In earlier series a number of references had been given to the self as a socialized person. This series was planned to bring out more of these references and especially those of a consociative sort. The statements were designed without regard to their factuality or truth. Formal instruction was:

Here is a statement. When you have sufficiently considered it, signal by tapping on the table. Then report in terms of function and product.

Results. We come now to the results obtained from the presentation of the material described. The questions we seek to answer are: What varieties of self-object (S-O) is the organism capable of turning out? What are the functions involved in their production? Do the functions and products vary with materials presented? What is the typical course of performance leading to the self-object? Is this course the same as that which produces other kinds of objects or does it differ in some essential way?

(1) A classification of self-objects. (A) The bodily self-object. This is the most obvious kind of self-object, the kind specifically studied above by Werner. It is the self-body or somatic object. Our somatic objects are either parts and regions of the body (topographical) or the physical organism at large (general).

(1) Topographical. We find products derived principally through visual, kinesthetic, and cutaneous patternings of a perceptive sort and designating many local regions and parts of the body. Instances are:[12]

Per (my arms) (*Lo-1-35*)
Per (position of right foot) > per (contraction of muscles in ankle) (*Ry-1-27*)
Per (body pressures from sitting) (*Ry-1-29*)

(2) General. The 'body at large' products also suggest a variety of receptoral excitations. Organic, kinesthetic, and visual modes are most used. We include pictorial modes as well as the apprehended flash. Our *O*s found no essential difference beyond the identification of picture and actual body.

Rem (looking in the mirror this morning and commenting at the time that I looked neater than I felt) > rem (sitting at a table with a group that I felt superior to in looks) > rem (looking in a three sided mirror and deciding that I have no classic features) > com ("no, I wouldn't call myself good looking") (*Le-2-32*)

[12] The parentheses following the name of the function involved contain the functional product. The last parenthesis holds the abbreviation for the *O*, the number of the series, and the number of the item in the series. For a standardized list of abbreviations used in the reports, see p. 224 above.

Per (face, looking strange) > insp (am I stooped) com ("I don't look as stooped as I expected") (*Ry-5*-3)
Per (my posture) (*Li-1*-29)
Rem (myself uncomfortable at a past time) > per (same distress) (*Lo-1*-6)

(B) Non-somatic and non-socialized self. We have found no positive characterization of this large group of products. The objects are distinctive but not bodily or socialized. The self-object is the individual referred to, the person designated by a certain name, the owner or possessor of certain objects, one who has individual characteristics and behaviors. Here we find three kinds which we have designated as simple, possessor, and doer.

(1) Simple. The self is the person referred to, or the person with a particular name.

Comp (the word as referring to me and my religion) (*Li-1*-14)
Comp (the word as referring to me) (*Lo-1*-44) and (*Ry-1*-18)
Comp (as me) > rem (other names for me) (*Li-1*-48)

Many of these references seem to involve a directional reference toward or from the *O* with a bare hint of socialization.

Fl (I wonder if *E* is referring to the fact that I smoke too much?) (*Ry-1*-49)
Per (a word, as though it were addressed to me by someone) (*Le-1*-44)

(2) Possessor. The self has, owns or controls.

Comp (word as meaning the things I possess) > imag (a number of things around me that were mine) > comp (these sweaters are mine. They have just come into that class of things which I call mine) (*Le-1*-34)
Comp (as meaning my thesis) > imag (my thesis) > rem (seeing my thesis on the desk upstairs) [a distinct myness about these] (*Li-1*-36)
Imag (shoes I wish to possess) > rem (trying-on shoes like them) (*Lo-1*-27)

(3) Doer. Here are not only products in which *O* apprehends himself as performer, but also those in which he imagines himself accomplishing certain aims or sets the task to accomplish them in the future.

Rem (shopping last hour) > com ("I finished that on time and I got everything done"). SI verb (what else might it refer to?) > com ("thesis") > imag (long line which seemed to be symbol for time till June) > comp (that's a long time; I ought to get it done) > rem (time I finished my thesis) > ("yes, I ought to get it done on time") (*Le-2-12*)
Com ("I should like to paint something like that") (*Li-3*-13)
Rem (riding the horse last summer) > fl (maybe that's why this is here) (*Ry-5*-29)

(C) Socialized self-object. In this class the product is the self-object sharing, appraising, belonging to, or connected with, a group; or with human-kind, its ways, rules and institutions.

(1) Congregated self-object. Although sharing and appraising are possible without physical conjunction, the most common occasions in which there is a congregative reference are crowds, meetings, audiences, and their like groupings.[18] Since (with the exception of the paired congregate between *O* and *E*) we did not actually set up, in our experimental work, such plural groupings we are chiefly limited to material which persuades the organism to remember or imagine such occasions.

[18] For a discussion of congregates and consociates in social psychology see M. Bentley, *The Field of Psychology*, 1927, 455-483, and W. L. Wright, Social significance, this JOURNAL, 49, 1937, 49-58.

(a) Sharing. The products of this group are best characterized by the use of the personal and possessive pronouns. 'You and I,' 'we,' and 'our' imply a sharing of activity or object.

(i) Sharing an activity.

Rem (sitting with others on a similar rock) > rem (boat ride I took with B and comment V made about it) > rem (dancing with R and comment about that) (*Le-5*-5)

Per and comp [The conversation seemed to belong to us, *i.e.* it was between us]. (*Li-6*-1)

Rem (conversation with P and our points of view on that subject) (*Lo-2*-14)

(ii) Shared *objects* have social significance, which may be immediately included in the apprehension of the object and may include reference to one or more human beings. In earlier products the self-object was central; here the possessed or the given object is central, but also there is an inclusion of the self-object as giver, receiver, or owner upon a socialized occasion.

Per (my paper weight which we used at a party) > rem ('I could not find it) > rem (same party and another stunt) (*Le-3*-2)

Per (our glass) > rem (our using and washing it the other night) (*Ry-3-5*)

Per (copper tea kettle I gave M) > rem (times it has been used when I have been there) (*Lo-3*-13)

(b) Self-appraisal. By appraisal we mean valuing or rating of the socialized person, *i.e.* the 'self.' We exclude non-human appraisal ('I am tall,' 'I weigh 140 pounds') as non-social.

(i) Permanent. O rates himself as generally 'that sort of person.' (Cf. the sociologist's use of 'traits.' Such terms as stupid, obedient, and honest denote some sort of fixed valuing or appraisal.)

Com ("should read 'students in both fields are making important advances' ") > comp (I am a reactionary, *i.e.* most are prejudiced towards their own fields, I'm not) (*Lo*-7-12)

Com ("I'm as educated in as many subjects as most people called 'cultured' ") (*Le-2*-22)

Generalized rem (self before class) > fl (no) > SI (try to evaluate honestly whether I would or not) > comp (self with others) > com ("I'll never be as good as X; I may be as good as the others") > rem (self before class) > com ("I'm a rather dry lecturer") > imag (C talking) > com ("I'm not as dry and pedantic as he") (*Ry-2*-32)

(ii) Temporary. A momentary rating or valuing (*e.g.* self-reproach); not a permanent characteristic.

Com ("I am stupid now: I can't think of anything to say") (*Le-1*-8)

Com ("I frequently am") > vague rem (I was recently) > S (for a particular instance) > rem (an error recently made) (*Lo-1*-8)

(C) In social predicament. Products characterized by an occasion in which *O* apprehends and appraises himself as sharing.

Rem (incidents very embarrassing and actual) (*Li-2*-19)

Imag *cum* comp (myself at table where everyone else was eating as this man did and all making fun of me) (*Ry-8*-9)

Comp (this may be from something I have been reading; she will think it queer if I don't recognize it) (*Ry-2*-41)

(2) Consociate. The self-object is directly apprehended as 'belonging to,' 'an-

swerable-to' or 'one of' a class, public, race, or institution. Physical presence is not necessary and not usually implied.

This belonging-to hints at the sociologist's family, church, school, club, profession, government, social status, etc.

The consociated reference to the S-O, when differentiated psychologically, falls into five classes:

(a) Member. The organized club, society, or church is the central product and the S-O is included in the product as a 'member' of the organization.

Comp (as the group to which I belong) (*Le*-7-16)
Comp (as referring to my fraternity, the one to which I belong) > rem (my fraternity brothers in college) (*Li*-7-16)
Comp (as referring to the church we attend) (*Lo*-7-25)

(b) Appraised group. By human appraisal *O* characterizes himself as belonging to a particular 'class' or 'level.' The 'class' may be social, financial, cultural, ethical, and so on.

Comp (I am a college graduate) (*Li-1*-19)
Comp (as definitely related to me, *i.e.* that I now belong in that class) (*Li*-7-19)
Com ("of course"): SI ("am I? what is a cultured individual?") > com ("I guess I'm educated in as many different subjects as most people called 'cultured'") (*Le-2*-22)

(c) Sharing group. The *O* comprehends himself as belonging to a group with which he often shares. Like the socialized congregate in which there is sharing, the group here is often referred to by the first person plural or possessive pronoun. This group is a more intimate group than the others. It is usually the family or the group which work or play together, *e.g.* with our *O*s, the graduate group.

Comp (a comparison of other departments) > com ("that may be true in some departments but not in ours") (*Li-7-2*)
Per (*my* family group) (*Le-5*-9)
Per (familiar picture of us) > series of rem > (when taken) > rem (funny incident connected with it) (*Li-5*-13)

(d) Specialized relationship. O is related to a group in a particular way and this relationship is the central part of the product.

Com ("naming possibilities of a job for me") > imag (institutional grounds) (*Lo-2*-47)
Imag (large segment of line: symbolic for next year) > rem (anticipating a possible job) (*Le-2*-1)
Rem (two instances when M wanted to go to her home) > rem (last time we were at my home; implied that first had to do with M as daughter and the second with me as son) (*Ry*-7-13)

(e) Regional. In this reference *O* comprehends himself as 'coming from' or being a citizen of a country, state, or region.

Com ("we Americans awkwardly hold the table knife") (*Li*-7-7).
Com ("I'm as American as most: I enjoy practical jokes") (*Lo*-7-24)
Imag (map of U. S. with towns in Ga., Mo., and Kan.: places I've been and where I'm from and where I have met cultured persons) (*Le*-7-10)

The following outline summarizes in classes and varieties all the instances of self-object thus far discovered in our experiments.

(A) The body as object
  (1) Topographical
  (2) General

(B) The non-somatic and non-socialized self-object
  (1) Simple
  (2) Possessor
  (3) Doer
(C) The socialized self-object
  (1) Congregate
    (a) Sharing
      (i) activity
      (ii) object
    (b) Self-appraisal
      (i) permanent
      (ii) temporary
    (c) Social predicament
  (2) Consociate
    (a) Member
    (b) Appraised group
    (c) Sharing group
    (d) Specialized relationship to group
    (e) Regional

(II) Distribution by series of varieties of self-object. Although no one of the series (save *Series 7*) was designed to bring out a certain class of self-objects, we do find (Table I) significant differences of kind with

TABLE I

DISTRIBUTION BY SERIES OF ALL FORMS OF SELF-OBJECT
(Percentages)

Class	Series 1 *(50)	2a (25)	2b (25)	3 (16)	4 (9)	5 (30)	6 (3)	7 (25)
Body								
Top.	22	19	5	3	0	14	**37**	2
Gen.	6	11	0	0	0	**51**	5	0
Non-social								
Simple	15	3	5	0	0	1	0	2
Possessor	**33**	1	**45**	**34**	**77**	10	5	4
Doer	7	**23**	15	**26**	15	5	**16**	**13**
Social								
Congregate	**14**	**29**	**20**	**38**	**8**	**9**	**32**	**6**
Consociate	3	15	10	0	0	10	5	*72*

* Total number of items in each series. The largest group of S-O in each series is in boldface.

differences in material, which served as a more or less differential occasional instruction. To bring out the relation of material used to the S-O induced, we give the distribution of all forms of S-O within each series.

With words as the inciting material (*Series 1*) over half of the references (55%) were to the non-socialized self-object. Next came the class of body-objects (28%), and socialized S-O last (17%).

There was no significant difference when the words were analyzed into parts of speech, save a slight advantage in favor of nouns. *O*'s last name and nickname always brought a reference to the self. Words which brought out a S-O for three of

the four *Os* had to do with *O*'s present occupation and interest (three *Os* were writing theses and words of this type were 'work,' 'thesis,' and 'typewriter'). There were only 6 words from which no *O* reported a self-object.

With questions (*Series 2a*) as the inciting material, the socialized S-O came most often (44%). Questions often led *O* to appraise himself as a member of a congregate. The remaining self-objects were chiefly topographical references to the body and the doer.

Quotations (*Series 2b*) brought fewer S-O than words and questions. Most were massed under non-socialized S-O. Quotations from *O*'s own writing were most frequently regarded as possessions or things done.

Familiar and possessed objects (*Series 3*) made the S-O either possessor, doer, or member of a congregate.

Signatures (*Series 4*) of the observers were chiefly regarded as possessions. Other signatures rarely led to a S-O.

Pictures (*Series 5*) induced primarily bodily S-O.

Series 7 mentioned some group to which *O* belonged and the consociated references to the self were natural products in about three-fourths of all cases.

Summarizing for all series, we find that the bodily self-object appeared 130 times, the non-somatic and non-socialized 174 times, and the socialized 153 times. The frequency was, then, approximately the same for the three large classes. The numbers attest the wide range of S-O derived from the occasions selected.

(III) Functions involved in the production of S-O. We have found that the self is an object similar in many ways to other objects produced by psychological performance. It takes many forms, wears many aspects, and appears in many contexts. Like other objects, again, the form taken varies with the kind of inciting material and the occasion. Our task now is to ascertain the means and methods used by the organism in creating the various kinds and appearances of S-O. We must inquire whether it is always the product of one single kind of activity or of a number of unlike activities. We must also consider whether each variety is produced by a single corresponding mode of function.

Our experiments have made it apparent that, for a given *O*, S-O may be the issue of any one of several varieties of performance; perceiving, remembering, imagining, acting, emoving, goal searching, inspecting, and comprehending.[14]

(A) Apprehending. By far the largest number of instances of S-O were appre-

[14] For a general discussion of the varieties of psychological performance see M. Bentley, *The New Field of Psychology*, 1934, Chap. I, and above, p. 222.

hended (283 of the total 457): about an equal number (2/5) perceived and remembered, and 1/5 imagined (as fiction or future). Under our experimental conditions, the self was most often described in spatial and temporal terms.

Instances of the apprehended S-O follow.

(1) Perceiving. The material and experimental setting most favorable for perceiving were the presentation of single words and pictures (117 cases).

Per (I was holding up my head) (*Lo 1-22*)
Per (I'm hungry) (*Li-1-25*)
Per (picture of myself) (*Le-5-19*)

The bodily self came usually through perceiving alone, but the non-socialized self commonly used also remembering, imagining, or some form of comprehending.

(2) Remembering. Isolated words and quotations most commonly (108) induced a memorial appearance of S-O.

Rem (jumping out of loft, and consequences) (*Le-5*-17)
Rem (I was uncomfortable on a particular occasion) (*Lo-1*-6)
Rem (J's joking me about being Irish) (*Ry*-7-18)

(3) Imagining. Here words and questions were most effective (58).

Imag (pressure in abdomen) (*Ry-2*-3)
Imag (being entertained at the White House) (*Lo-2*-25)
Imag (my office) (*Li-1*-5)

(B) The executive functions. The actional task, sheer determination, or emoving may be used as a means of constructing S-O.

(1) Acting. Although experimental conditions were scarcely favorable, several instances of S-O from *acting* were given. For example, a task was formulated, with deferred resolution.

Task (I must try civil service and write various persons) (*Le-2*-1)

(2) Emoving. An example of S-O in one phase of an *emotive* cycle is the following:

Imag and comp [dramatic situation] (I wish to get M something for her birthday). [This was predicamentive: I can't do it. This predicament has arisen whenever I have thought of her birthday]. (*Ry-1*-30)

It is obvious that neither our situation nor our *O*s encouraged the kind of boasting, pitying, and deprecating 'self-reference' which is all too common upon many occasions.

(C) Inspecting. Examples of inspecting were somewhat rare (36). About half of these occurred with pictures.

Insp (to see if I were stooped) > per (didn't look as stooped as I had expected) (*Ry-5*-3)
Insp (of face to determine age) > per (looked younger than I had expected) (*Ry-5*-9)
Insp (of face) > com ("a terrible picture") (*Li-5*-19)

(D) Comprehending. The self-object was imbedded in a comprehended topic as frequently (136 times) as it was a perceived or remembered product. Words, questions and statements led to the formation of a 'self' topic and its elaboration.

Comp (I'm different now) > [elaborated by vis] imag (myself at age of 15, red hair and blurred features, self-conscious and uncertain. This was symbolic of non-directed activity, not clearly related to other people) > imag (myself now, again red hair this time with features more angular, I was more confident, and knew what

I was going to do next, this symbolic for more directed activity with a design) (*Le-5*-5)

Comp (as my accomplishments) > [verb elaboration] (graduation from college, etc.) (*Li-1*-23)

(E) Searching. There were 9 cases in which search was involved in the course of the production of S-O. Six of these followed questioning.

S (to rem instances) > rem (two instances) (*Li-2-19*)

S (to imag how I would appear to others in this respect) > imag (self in classes and in office) com (I don't think I am as stodgy as some) (*Ry*-7-16)

We found, then, that any one of the functions (with the exception of thinking) was used alone or in integration in the production of some form of self-object.

The extent to which a certain kind of S-O is produced by a particular mode of performance is illustrated in Table II.

TABLE II

RELATION BETWEEN KIND OF PRODUCT AND FUNCTION

Class	Per	Imag	Rem	Insp	Comp	Act	Search
Body							
Top.	42	11	7	10	1	0	2
Gen.	28	6	9	17	1	0	0
Non-social							
Simple	6	2	0	1	16	0	0
Possessor	27	17	23	4	14	2	0
Doer	1	13	33	1	10	1	3
Social							
Congregate	6	4	28	3	48	1	4
Consociate	7	5	8	0	46	0	0

A general similarity appeared among the various *Os*.[35] Perceiving most often produced bodily and possessor selves. 'My' and 'mine' were most in evidence in *Series 3* when *O* was shown his own things. Imagined products showed the self either as possessor or as doer, the former coming out of the fictional kind of imagining, as of something coveted, and the latter as a previsied or desired activity with a 'self' tinge. Remembering was useful in turning out possessor or doer, often in a social context. Inspecting led almost always to a bodily object. The clearest instances came when *O* was shown his own portrait. Photographs new to *O* especially aroused inspective processes. Comprehending typically brought a self-object either socialized or non-socialized. In the congregative references, it brought self-appraisal.

A summary of this material reduced to percentages for the three main

TABLE III

CLASSIFICATION OF SELF-OBJECT AS RELATED TO INDUCING FUNCTION
(Percentages)

Class	Per	Imag	Rem	Insp	Comp	Act	Search
Body	60	29	15	75	1	0	22
Non-social	29	55	52	17	29	75	33
Social	11	15	33	8	70	25	44

[35] There are exceptions. *Le* had more instances than the others of remembering S-O as doer; *Ry* of perceiving S-O as a part of the body; and *Lo* and *Li* of deriving the various kinds of S-O through comprehending.

classes will show the numerical side of these facts of function and induced S-O.

The summary brings out the shift from perceiving to comprehending as we move from the bodily self through the non-socialized to the socialized instances. Imagining and remembering stand intermediately in so far as they have the largest number of cases under the non-socialized class. Most actions fall into the non-socialized group. While we cannot generalize from these results, it is interesting to observe how occasion, function, and product may stand related in a given setting.

PART II

The 'personality test' is commonly regarded by its advocates as a method of studying, diagnosing, testing, and treating the self. The questions which compose it frequently elicit a reference to, but do not psychologically describe, the self-object. To augment our description and for the sake of comparing unlike methods of study, we have made use of certain questions taken from these tests.[16]

Our own interest lies in comparing products and course of performance in the testing situation with our results obtained in Part I. We have desired specifically to discover whether these interrogatories lead to the same varieties of self-object which we have ourselves found, and also whether the self-object is produced by the same functional means under the two sorts of method.

To these ends we have included an experimental series consisting of questions taken from a typical test; the Bernreuter *Personality Inventary*.[17]

Fifty of the test questions were chosen in haphazard order. All *O*s answered the same questions in the same order. *O* was seated comfortably in a darkened room. The questions were read in succession to him with the formal instruction:

I shall read you a question. Answer *immediately* by reporting either 'yes,' 'no,' or 'no report.' Then report in terms of function and product. Here is a sample. . . .

After the sample, *E* explained that no attempt to 'rate' or assess *O* would be made, that the object was to secure a full and accurate report of operation and outcome. After another sampling, the main questions were read to *O*, one by one, with ample time after each for report.

O's task was somewhat different from that which is set up in formal 'testing,' for we demanded a report in technical terms and did not 'rate' or personally examine. We found, nevertheless, that the self-object was appealed to in the same general way.

[16] For the construction, application, and interpretation of tests of 'personality' see H. E. Garrett and M. R. Schneck, *Psychological Tests, Methods and Results*, 1933, 1-372.

[17] R. G. Bernreuter, *The Personality Inventory*, 1931.

Results. (1) Forms of the self-object. Kinds and frequency of appearance are shown in Table IV. No new classes were reported by our four *Os*, each of whom was given 50 questions and made a like number of reports.

From the table it appears that questions which probe for 'personality' tend to yield answers based upon two self-objects; the *doer* and the *appraised.*

TABLE IV

FREQUENCY OF FORMS OF SELF-OBJECT

Kind of S-O	Times	Kind of S-O	Times
Body		Socialized	
Topographical	0	Congregative	
General	1	Sharing	0
		Appraising	123
Non-socialized		Soc. pred'mt	3
Simple	3	Consociative	0
Possessor	0		
Doer	73		

The self as *doer* appeared memorially or imaginatively as performer and the remembered or imagined performance gave the cue to the answer and led on to the appraisal of the self; or else the S-O as doer followed a self-appraisal and served to substantiate it.

Rem (reading things and laughing) > ("no") (*Lo-8*-3)

Rem (persons annoying me by telling me what, when, and how to do things): comp (I quite often ask how to do things; it doesn't bother me then. It depends on how they tell me) (*Le-8*-12)

Comp (no, I never do): OI to give verbal "no": SI (check report until I get instances to support answer) > rem (teas, etc. where I haven't talked much) (*Ry-8*-24)

TABLE V

SELF-OBJECT AND FUNCTION

Kind of S-O	Imag	Rem	Comp	Insp	Search
Body					
General	0	1	0	0	0
Non-socialized					
Simple	0	0	3	0	0
Doer	13	59	1	0	7
Socialized					
Congregative					
Appraising	2	5	116	2	11
Soc. pred'mt	1	2	0	0	0

The *appraised self* corresponded, with one exception, to the class which, in Part I, we have called 'permanent.' The self was comprehended as usually being of a certain sort.

Comp (I am that sort) (*Li-8*-12)

Comp (I am not that kind of person) (*Lo-8*-4)

Comp (as professional criticism of self which is justified and useful; while I usually make use of it and have a reputation of being a 'good sport' about taking it, I am still hurt) (*Lo-8*-1)

There is a strong hint in these experiments that questions meant to prove and

reveal 'personality' are extremely limited and biased in the range and variety of the self-objects which they create in the individual submitting to the test, chiefly putting the subject before himself and exacting self-values and self-appraisals.

(II) Functions involved in answering the questions. Not only are the forms of the self-object selective and limited by the questions; the functional resources of the organism are likewise limited. We found no perceiving, thinking, acting, or emoving, and only two cases in which inspecting was reported.[18] Comprehending was involved most often, remembering next, and search next. These functional facts are tabulated in Table V.

The results here substantiate our earlier discovery that comprehending is usually involved in the production of socialized self-objects, but that it rarely is present in the production of the simpler forms, bodily and non-socialized.

Course of performance. The course of the total performance took—as it likewise took in Part I—one or the other of two lines of development. Either the self-object appeared instantaneously or it developed progressively upon searching and self-instruction. Often the self is immediately comprehended as 'that sort of person' but supported by a stock estimation ready-to-hand. The answer in cases like this was fairly automatic. In other instances, an unrated self-object appeared in one or more particular situations, immediately after the comprehension of the question, and from these examples developed a comprehended S-O as having a certain rating.

In only about one case in eight was there searching or self-instructing before the self-object was created.

Our results in this series indicate, then, that the self-objects which the tests of 'personality' produce are of the same sort and produced in the same way as the S-O produced by the experimental conditions of Part I. They further suggest, however, that the tests of 'personality' are narrowly limited in the functional modes which they employ and in the variety and range of the self-objects produced.

Conclusions

Like other psychological products, the self-object takes many forms, appears in various contexts, and may be produced in divers ways. Its main forms are (1) the *bodily* self-object (a local feature or area or the body at large), (2) the *non-bodily* and *non-socialized* self-object, which bears a name, is possessor of objects, performs tasks, and (3) the *socialized* self-object, which shares and appraises, is a member of congregates, and inheres in consociates.

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[18] We anticipated that these personal questions would incite emotion. After the completion of the series, *E* asked the *O*s if they could explain why none had been reported. Three *O*s opined that the situation governed them to perform in other directions: the fourth *O* that it was because the possibility of giving the response of 'no report' was allowed.

The kind of self-object produced on a given occasion depends upon the inciting material and upon antecedent psychological activities. Under our experimental conditions, the total number of reports was about evenly divided among our three main classes.

All psychological functions (with the possible exception of thinking) may be involved in the production of self-objects.

The kind of self-object produced is partially dependent upon the functions involved; *i.e.* the bodily self comes primarily from the apprehending functions, the non-socialized from apprehending and comprehending, and the socialized chiefly from the comprehending forms.

The self-object may be instantaneously produced under occasional instruction or it may develop gradually under search, with self-instruction playing a prominent rôle.

Questions from a typical 'personality test' led to the same classes of self-object as the method of verbal and pictorial presentation revealed, but the testing interrogatory chiefly evoked self-appraisal and the 'doing' self. Functional resources employed were limited in a corresponding way.

APPENDIX

Series 2A

1. What are your plans for the future?
2. Would you stand on your head in the center of the quadrangle?
3. Did you eat too much?
7. Does your head still ache?
8. Would you yell for Cornell at the Penn-Cornell football game?
12. Will you finish on time?
13. How old are you?
14. Do you believe the study of psychological governors important?
17. Does your shoe hurt your foot?
19. Were you embarrassed?
22. Are you a cultured individual?
23. Would you like to be a great writer?
25. Would you consider it an honor to be entertained at the White House?
26. If the United States went to war would you 'do your part' to help?
27. Is your record good?
31. Will you be a good lecturer?
32. Are you good looking?
33. Would you like to be a great musician?
36. What are you going to do?
38. Do you believe that psychological activities can be placed in the S-R formula?
39. How do you feel?
42. Did you flunk the course?
43. Did you step in the soft cement?
46. Are you conceited?
47. Will you take the job?

Series 7

1. The boorish person laughed at the most serious point of the sermon.
2. Advanced degrees mean very little. Individuals too lazy to work find graduate study a convenient excuse.

3. The smiling hostess offers as the pièce de résistance sandwiches made with spoiled butter.
4. The library book accidently damaged should be destroyed and never reported.
5. Cornell is not only backward in educational methods but the faculty of its Arts College is weak.
6. The clever person is boisterous in a public restaurant in order to attract attention.
7. A citizen of the United States, unlike citizens of most countries, is allowed to criticize his government at any time.
8. The members of the Psychology Department are a congenial group.
9. An American is often laughed at because of the way in which he handles his knife at the table.
10. Persons from the North Atlantic states are more cultured than those from other sections of the U. S.
11. The working class has insufficient leisure.
12. Those persons working in the sciences of the human organism are making more important advances than those working in any of the other sciences.
13. Sons (daughters) are more devoted to their families than are daughters (sons).
14. Undergraduate students are reckless drivers.
15. Actors are temperamental.
16. Members of (club of which *O* was a member) are a serious-minded group.
17. Lawyers are the most interesting conversationalists.
18. The Irish are carefree.
19. Individuals who have little money have little to worry about.
20. Doctors are impractical in business affairs.
21. Law-abiding citizens are honest but dull.
22. College graduates are more tolerant than uneducated persons.
23. Germans are thrifty.
24. Americans have a perverted sense of humor.
25. Members of (church of which *O* was a member) are narrow-minded.

AN EXPERIMENTAL STUDY OF ANTICIPATION

By ROBERT M. LINDNER, Cornell University

The perceiving of the present often passes directly over into the apprehension of the immediate future, the apprehension of the not-quite-yet-but-about-to-be. I perceive my playmate's uplifted arm and apprehend the ball about to fly toward me. I look at my wrist-watch and anticipate the impending announcement of the hour by the chimes in the Library Tower. Writing here in my study I hear a fumbling at the doorknob and anticipate the appearance of my colleague. Waiting on the corner for the bus I perceive its rumbling noises and realize that it is about to round the turn and appear.

A good deal of life is spent in anticipating a future which is not quite at hand but is implied in certain special characteristics of the perceived present. It is a remarkable and invaluable accomplishment of the organism. Through it the present is both enriched and extended toward the future.

Our problem is to describe this transitional mode of apprehending, relating it at once backward to a more primitive aspect of organic function, primitive searching, and forward toward that prophetic form of imagining which forecasts the remote and independent future.[1] Since acting too has its anticipative and predictive aspect, we shall also have to be alert for relevant facts in that direction.

History of the problem. The 'edge of perceiving,' which has been discussed under many names by psychological writers, has generally been badly and ineffectively treated. Brief comments on the problem, hidden away in chapters on thought, emotion, feeling, attention, perception and imagination, have been more or less cursory, and dependent, for the most part, on traditional generalization rather than on experimental evidence.

First, anticipation stands related to expectation. With Külpe, for example, expectation (we use his own term) is the consciousness of, and preparation for, something to come.[2] The preparation involves, on the physiological side, adjustments of the organism, and it includes ideas about the coming event plus an affective state in relation to it. Wundt places anticipation at the periphery of apperception.[3] It is a 'feeling,' dependent upon the disposition of the mind as governed by its experience with what is expected. It is also an 'emotion,' characterized by tenseness of muscle,

* Accepted for publication May 20, 1936. The study was done under the direction of Professor Bentley in the Research Laboratory, Cornell University.

[1] M. Bentley, *The New Field of Psychology*, 1934, 20, 241, 294, 364.

[2] O. Külpe, *Outlines of Psychology*, 1895, 39.

[3] W. Wundt, *Human and Animal Psychology*, 1896, 248.

and leading to satisfaction or disappointment. Wundt makes much of the kinesthetic sensations involved and stresses the painful consequences of prolonged expectation.[4] For Titchener expectation is (following Külpe) *anticipatory attention,* which is simply attention to the idea of what is anticipated.[5] It is commonly composed solely of kinesthetic and organic sensations deriving in part from the "bodily attitude of attention." Verbal ideas may or may not be present, and occasionally there is an imaginational accompaniment. "Expectation shows nothing unique or ultimate behind or beyond kinesthetic and organic sensations held together by the perceptive suggestion."

Ebbinghaus speaks vaguely of expectation as a form of willing,[6] as a 'set-of-the-mind.' His argument is that often we apprehend our own muscular activities as characteristic of those adaptations made in the course of 'attending' to a certain something. Out of this emerges a 'foreseeing' of the activities, which he has called 'willing.' In a similar way, Lipps characterizes anticipation by a 'striving,' a consciousness containing an image 'trying' to become a perception.[7] The striving is implied by strains and other organic sensations.

With Stout the problem is, again, attentional in character,[8] a pre-adaptation of sense-organs to receive the 'impressions' which are on their way, combined with an instinctive pre-adjustment of the organism to act in accordance with what is coming, an earlier psychological accomplishment than memory.

Angell stresses the importance in anticipation of the image and kinesthetic sensations.[9] He also recognizes the necessity of anticipation for action. Kirkpatrick makes much of anticipatory images and believes that the ability to continue a series denotes an anticipatory idea.[10]

The most important of the earlier articles touching anticipation is from Pyle's study done in Titchener's laboratory.[11] Pyle's *Os* 'anticipated' objects to be perceived through eye, ear, and dermal excitations, as well as words, numbers, geometrical figures, and so on. He meant to discover what "the mind is like when it is waiting"; what it is to "await a thing with the assurance that it is going to happen"; and what the difference is in a "relation that exists between two perceptions connected by a tie of expectation" and "between two perceptions that are otherwise connected."[12] His fundamental assumption was that expectation is a state of consciousness in which one perception is followed by another, the first perception giving rise to the expectation of the second. His experiments gave strong evidence of strains about the eyes, of organic sensations, verbal ideas, and auditory and visual 'images.' Images may or may not be present; but strains, organic sensations and verbal ideas are always 'in consciousness.' Bodily conditions underlying the initial perception are chiefly responsible for these. Pyle distinguishes two classes of expectation. The one is 'definite' (containing a pattern prescribed in experience); the other is 'indefinite' (the organism

[4] *Idem, An Introduction to Psychology,* 1912, 53 ff.
[5] E. B. Titchener, *A Primer of Psychology,* 1898, 153, *A Beginner's Psychology,* 1915, 273.
[6] H. Ebbinghaus, *Psychology,* 1908, 94.
[7] T. Lipps, *Grundtatsachen des Seelenlebens.* 1883, 669.
[8] G. F. Stout, *A Manual of Psychology,* 1913, 159, 629.
[9] J. R. Angell, *Psychology,* 1908, 163.
[10] E. A. Kirkpatrick, *Genetic Psychology,* 1909, 129.
[11] W. H. Pyle, An experimental study of expectation, this JOURNAL, 20, 1909, 530-569.
[12] *Op. cit.,* 535.

being at a loss to know what to do). Since *O* is ignorant (in indefinite expectation) of the nature of what is to come, no 'image' appears, but organic and strain sensations and adjustments of sense-organs and musculature are observable, as in the definite form. Pyle's results tend to discredit Wundt's essential 'idea' (or image) in expectation and also the various emotive interpretations. Pyle calls expectation an *habituated consciousness* in which the initial perception realizes a 'set' or attitude. It manifests itself through kinesthetic sensations which are preparatory in function. Bissel studied the sort of forward-tending which comes from running through musical phrases.[13] His material is good but his method poor. Since he was interested only in affective states, he chiefly turns up such 'emotive' things as surprise, laughter and shock.

Hints regarding expectation and anticipation have come from the 'reaction' and 'thought' experiments of Titchener, Külpe, Watt, Ach, Messer, and others; but no one of these has seriously described these affairs as distinctive performances.

History, then, nets us very little. These anticipative states have been variously designated as preparatory, anticipatory, or expectant attention, as an expectant consciousness, as an emotion, a feeling, an idea, a striving, and an habituated consciousness. Some writers have insisted on the image. Some have declared that strain is the chief factor. Some have emphasized the *context* (thought, emotion, feeling, acting, attention, or perceiving). Before Pyle, no one had subjected the problem to experimental scrutiny. Conclusive evidence is definitely lacking. We therefore seek further information on just what the organism is doing while it 'anticipates.'

The Experiments

First we sought to imbed anticipating in a controlled perceptive activity and secondly to give it an actional setting.

Perceptive anticipation.

Apparatus. Our apparatus had a wooden runway (6 ft. long) descending from the right to a black square box (2 ft.) fronted by a glass window (15 in. square). A copper ball released at the top of the runway made a buzzing contact as it passed over metal plates. When the ball reached the lower end of the runway just before *O* (seated in the lightless room), it touched a knife-switch which weakly illuminated (by means of red bulbs set in the sides of the box) the interior of the box, enabling *O* to view the one or the other of two pictures done in water-colors. One buzz (only the lower pair of strips made electrically active) was the signal for the appearance of a rolling landscape containing a winding river with a bridge in the background. Two buzzes (two pairs of strips thrown successively into action) was the signal for the appearance of a picture containing sharp-peaked mountains, a body of water, and a cabin in the foreground.[14]

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[13] A. D. Bissel, *The Rôle of Expectation in Music*, 1921, 1-74.

[14] The observers for the experiment were Harold F. Dahms (*D*), Sarah G. Longwell (*L*), Mary S. Ryan (*R*), and W. H. McCann (*M*), graduate students in psychology.

Method. In preliminary trials *O* was instructed merely to report what happened. The trials were discontinued when *O* reported that he looked for the 'mountain scene' after two buzzes and for the 'river scene' after one buzz.

In the main experiments (25 with each *O*) *O* was seated about two feet in front of the apparatus. The lights were turned out, and the following formal instructions spoken:

Look straight before you throughout the experiment. Report fully from the warning signal 'now' in terms of function and of functional product.

Caution: You may neglect the set-up of the apparatus and the task and plan of the experimenter. The order of presentation is haphazard. You are to report all items in order of occurrence and to include also all self- and occasional instructions.

At the conclusion of the main experiments, a short series followed in which no picture was shown (only the perceived rolling and clicking). This enabled us to obtain a clearer description of anticipatory phases.

Results. The reports were fractionated into three successive stages.[15]

Stage 1

R S (something to come).
[Later it took on the character of] S (a forecast of 'buzzes' and 'a scene to be viewed').

D [No report for preparatory foreperiod.]

L Per (body-objects: visceral and thoracic tightenings bearing a tinge of 'something to come').

M S (straining to see into the darkness) *cum* SI (listen, wait, or count the buzzes).

Stage 2

R Per (buzz or buzzes) > imag (the scene to follow). [Later searching and perceiving (buzzes) were telescoped into a first stage, and the second stage then ran] per (something rolling downward and toward the front) *cum* Pant [the rolling was also anticipative of] (picture-to-come). [No images and no strains or organic objects.]

D Per (buzz and rolling) > fl (buzz = scene to come). [The buzzes were not simply perceived; they carried in them a reference to the future. [At times] com ("mountain scene is coming") or imag (view of the scene) replaced the flash.]

L Per (buzz) > fl ('coming') or imag (object to come) or per (time going on).

M Per (buzzes = clues to the picture to come) > fl, imag, vis, or com (all prophetic references to the picture about to appear).

Stage 3

R Per (the picture) > fl (here it is).[16]

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[15] This research, which was begun before the two which precede it, presents an earlier and more informal stage of our method of report and record. A list of the abbreviations used will be found on page 224, above.

[16] J. M. Hunt, A functional study of observation, this JOURNAL, 47, 1935, 21. "They [the flashes] are undoubtedly the same phenomena as the *Bewusstseinslagen* found in the reasearches of the Würzburg School. When they are regarded functionally, it is plain that they are an exceedingly valuable accomplishment of the human organism. They reinstate the task in the course of execution, embody the queries about objects . . . , and even supply a topic. . . . Though . . . non-verbal they appear to do almost everything achieved by language itself."

At times the order was fl > per > insp (scanning parts of the scene) > per (dark field + picture gone).

D Per (the picture scene) sometimes preceded by fl (is my imaginal scene the correct one?).

L Per (picture) *cum* per (body object: relaxed state) > fl (yes; it is that scene).

M No report for Stage 3.

From the foregoing observational reports we are led to conclude that, in the course of a perceptive performance such as ours, the anticipatory phase includes several functional variants. Before the picture is perceived, appear searching, flashes, verbal comments, imaginational objects, and body-objects. Prominent is a prophetic searching, with and without goal, sometimes supported by imaginational objects and sometimes by flashes. The anticipative phase of the performance set by our conditions plainly falls under the family of apprehending functions. Its specificity lies in its forward-tending temper. In character it bears the marks of perceiving and also the marks of imagining. It would seem to be transitional between these two highly developed activities. It is not quite presentness and neither is it detached futurity. We shall learn more about it as we compare it with its 'actional' counterpart in the following pages.

An attempt to induce actional anticipation. Here we tried to provide for the emergence of anticipation as a phase of an actional performance.

Apparatus. Again we provided balls rolling down an incline and producing audible clicks, but now the balls are rolled down three parallel compartments or chutes and come out directly before *O* who sits prepared to catch them. *O* heard 1, 2, or 3 clicks and then a ball appeared at one of the three openings; one click brought the ball (rubber) at the left opening, two clicks at the middle opening, and three at the right. *O* did not know this arrangement before the experiments began. The chutes were 5 2/3 ft. long and the sharp noises were provided by squares of paper (1, 2 or 3) which 'clicked' as a descending ball rolled beneath them.

Method. In the main experiments (25 with each *O*), *O* was seated comfortably before the apparatus, so screened that he could see only the emergent end. The formal instruction was:

> At a short but variable time after the preparatory signal 'now,' a ball will emerge from one of the three openings. Secure the ball in your hands as it comes out and hold it quietly during the report. The securing of the ball terminates the observation. Report all functionings in the order of their occurrence, beginning with the preparatory signal 'now.' Report also all self- and occasional instructions.
>
> *Caution:* The experiment is not a test of skill or intelligence. You may neglect the set-up of the apparatus and the task and plan of the experimenter. The time-place order of the balls is haphazard.

Results. The reports fall naturally into two periods. The first ends with the perception of the paper-noise objects; the second with the securing of the ball.

Stage 1

R SI (listen for the sound of the ball rolling and clicking) > S (straining and 'seeking' with a forecast toward a noise) *or* S (awaiting without forecasting).

OI (the general situation instructed to waiting or forward-referring). It included the lifting of the hands to receive the ball. The stage also contained com ("where is the ball going to come from?") > imag (the ball coming from one of the openings; almost hallucinatory at times).

Fl (something is going to happen here!) > per (noise-object), [short, swift movements of the hands to a position favorable to catching the ball.]

Per (body objects = arm and other strains) *cum* S.

D Per (strain and organic objects) *cum* S (something-soon-to-be-heard).

~~Fl~~ (the about-to-happen).

SI (search for the sounds that are coming).

Per (the signal to begin), [no anticipative hint of movement to be made and no search.]

L S (waiting, anticipatory apprehension) > per (forward straining) *cum* com ("where will it come from this time?" "Will it emerge from chute 3?" "I must prepare to catch it.")

M S (the emerging ball and significant number of clicks).

SI (look expectantly; rehearse formal instruction).

[Strain-objects played a minor rôle.]

Stage 2

R Imag (clear pictures of the ball in motion in a certain chute).

Fl (indicating the correct chute).

Per (movement of the hands > ball in hands).

[Rarely an apprehension of the catching.]

D Fl ("here it comes!" "It's in the first chute!") > imag (forward-referring of the ball either on its way to the mouth of a certain chute or already there).

S (ball in a certain chute).

[Search was restless, out-going, seeking, extending beyond the perception which released it. Only thrice did *O* actually perceive his movements to secure the ball.]

L Per (body-object: relaxed) > per (the clicks).

Fl (the chute from which the ball is to come).

Imag (ball is on its way in a certain chute).

[Movement was seldom perceived or anticipated in this period.]

M Per (moving hands and arms).

["Only when I moved inaccurately and had to readjust my hands did I perceive their movements. Otherwise I neither perceived movement nor anticipated it."]

We have attempted to show in Table I the distribution of the various functional moments involved in a performance which was originally planned to develop actionwise rather than toward the perceptive outcome (the pictured scene).

Here again searching is very much in evidence. It appears in the first stage of the performance as a restlessness for the arrival of some un-

realized functional product. Various incidental moments (flashes, imagining, comment, self-instruction, body-strains and -pressures) come in, in varying degrees and patterns for the four *O*s, all forward-tending and helping the organism by way of government to hold its determined way toward the about-to-come.

Although we had provided a functional termination (a coördinated movement of the hands in catching the ball), the organism avoided the actional outcome and again *determined itself toward a final perceiving, i.e.* the apprehension of the emerging ball. Reports show that after the emerging-position was perceptively ascertained, there was little or no

TABLE I

FUNCTIONAL ANALYSIS OF BALL-CATCHING

Stage	*O*	Searching	Flash	Imaging	Comment	SI	B-O	Per. Move.
1	*R*	19	10	9	3	9	8	—
	D	13	2	1	—	10	13	—
	L	21	—	5	6	1	15	—
	M	19	5	—	1	8	2	—
2	*R*	—	5	8	—	—	—	6
	D	—	16	11	—	—	—	2
	L	—	18	3	—	—	—	3
	M	—	2	1	1	—	—	7

anticipation or realization of movement, and, moreover, the catching of the ball was not, as a rule, apprehensively noted. The perceiving of the noises made by the ball as it brushed against the suspended squares of paper, the localizing flashes, and the forward-running imaginings sufficed to govern and to determine the performance and to direct it toward an apprehensive, instead of an executive, end.

As between the two experiments, then, we have found a smaller difference than we had expected. The movement-end did not, as we had anticipated, complete an actional determination in our second experiment. Instead, the preparation for hand-movement was carried on in a wholly accessory (often a non-psychological) way as initiated by the various forms of instruction. The functional turn came midway, where the actional determination disappeared and so failed to develop, and searching led on toward a perception of place-of-appearing-ball. Only the body-objects (strains and organic components) remain to bear witness to the abortive action. Searching is the chief functional agent here in replacing the middle stage of the common impulsive action and carrying the organism on toward the perception of the appearing ball as from such-and-such-an-opening out of the concealed pathways. Thus the conditions set for our second set of experiments have thrown new light upon the nature of functional

searching, which—as it appears—is a prominent ingredient in anticipatory apprehending. Students of the experimental history of action (the reaction-experiment) will recall the old distinction between 'sensory' and 'motor' forms, a very important distinction for functional description. In the 'sensory' form the accent was on the perceptive side ("attention to the stimulus," as the phrase ran); but there the accent fell in the fore-period, modifying the course but not obstructing the outcome.[17] In our present case, however, although formal instruction provides for a typical action, the events of the occasion (OI) deflect it as we have observed. The result is an interesting intermediate between perceiving and acting, with perceiving the closer affiliate.[18]

Summary and Conclusions

Anticipation, in the course of a perceptive performance, we have found to be mainly concerned with a searching in which goal and resolution are only partially forecast. Under the task imposed, the observer seeks a deferred accomplishment. Imaginal objects, flashes, body-objects, and comments supply governmental aid in maintaining a determined course toward a future outcome.

Anticipating, then, stands closely related to the apprehensive functions. It is of the 'searching' variety; it is forward-tending, and it contrives a forecast of goal and resolution. In spite of its close affiliation with perceiving and imagining, it may—as we have been able to show in our second problem—supply an instructive intermediary between apprehension and action.

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[17] Bentley has called this form of the simple action the *apprehensive action* (*New Field of Psychology*, 1934, 213-216, 396-397) and has given it a functional description in the sense of the present study.

[18] It may well be that a reexamination of remembering and imagining, especially of those forms of imagining common in artistic and inventive production, would reveal similar intermediaries with action.

PROGRESSIVE CHANGE IN SIMPLE ACTION; A STUDY OF LEARNING

By SARAH GERALDINE LONGWELL, State School, Vineland, N.J.

It is our aim to study learning by way of a description of progressive changes in simple action. By 'learning' we shall mean simply those modifications in course and in issue which appear under the continuation or repetition of a function or of a combination of functions. With educational, occupational, and other forms of gain, acquisition, and advancement we shall not be concerned. Acting we shall regard as a psychological function which includes in its successive stages a task, a prophetic forecasting of something-to-be-done-by-way-of-body-movement, and an appropriate resolution of the actional task by organic and other means.[1]

Many experiments have revealed the typical forms and varieties of acting, the conditions of initiation and control, the measure of skill, decrease in time under practice, and the various economies of repetition; but a descriptive account of the precise changes in course remains for the present study.

Selection of an experimental situation where these changes may be observed and described is difficult. Most simple actions are highly practiced and hence too abbreviated or automatized for adequate description in course. More complex forms involve too many psychological activities to be adequately described in a simple orderly fashion. It is desirable, therefore, to select unfamiliar situations requiring relatively simple acting.

In attempting to meet this requirement only partial success was attained. The problems selected were novel chiefly in their recombination of well-known elements from many simple tasks. The devices used were (1) to capture rolling balls, (2) to duplicate 'silhouette' figures, and (3) to trace reflected patterns. All of these devices provided occasions for describing the activity by stages and for setting varieties of task in the course of progressive functional modification. They differed among themselves in opportunities for appropriate occasional instruction and in the variety of psychological functions called forth.

From these problems, then, we seek answers to the following questions. (1) What tasks are set in the simpler forms of acting? How do the tasks arise? and How are they modified under repetition? (2) How does the

* Accepted for publication May 15, 1937. This study was directed by Professor Bentley in the Research Laboratory, Cornell University.

[1] Madison Bentley, *The New Field of Psychology*, 1934, 175-208, 209-231, 393-397.

'determination' develop? and How does it change as the acting is carried through time after time? (3) What are the inducing and guiding factors in the progress of such an action? and How are these factors modified in successive performances? (4) What are the antecedents and sequels of the motor phase? and How is the motor phase affected by repetition? (5) What is the entire, integrated, functional course of acting in its simpler forms? and, finally, What essential changes occur under repetition, changes which are commonly masked under the phrase 'learning or perfecting the act?'

The Experimental Procedure

O was set a number of elementary problems which could be easily performed action-wise. Reports on the course of the functional operation were called for. The

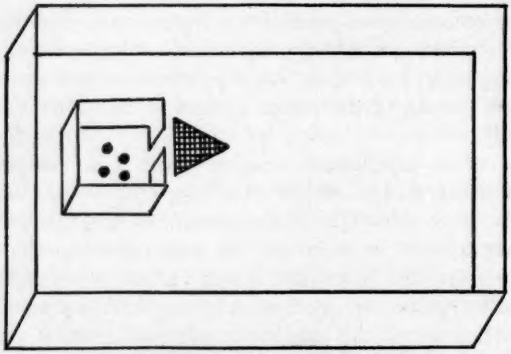

Fig. 1. Apparatus Used in Problem I

problems were repeated until performance became fixed or invariable. The number of repetitions naturally varied with the problem and with the observer.

Problem 1. The capture of rolling balls. The task set was to roll four small steel balls into a wire cage set in an enclosed plane. The balls and cage were enclosed in a cardboard box 6 in. x 8 in. and 1 in. deep, all covered over by cellophane. The solution, by outside bimanual manipulation of the box, is possible to anyone without gross physical handicap who comprehends the task (cf. Fig. 1).

This preliminary problem was selected because (1) it provided divisible and describable stages in solution, (2) it gave ample scope for variations of task in terms of everchanging occasional instructions,[2] and (3) it permitted, through repetition, a study of those progressive functional changes which are the essence of 'learning.'

[2] The influence of informal instruction upon the course of psychological operation is discussed by O. F. Weber and M. Bentley, Relation of instruction to psychosomatic functions, *Psychol. Monog.*, 25, 1926 (no. 163), 1-15. *Cf.* p. 206, above.

Formal instruction was as follows:

You are to manipulate the box until one ball is inside the cage, giving a full functional account as you proceed. Be sure to distinguish product from function and to report the temporal sequence of your operations. Try to differentiate the various periods of action. . . . Now cage the other balls, one at a time, reporting as before.

Problem II. Dissected 'silhouette' figures. Ten filled black pictures representing animate objects in various poses were printed, each on a separate small white card. Seven irregularly shaped block pieces were provided with which *O* was to duplicate each figure (Fig. 2).[3]

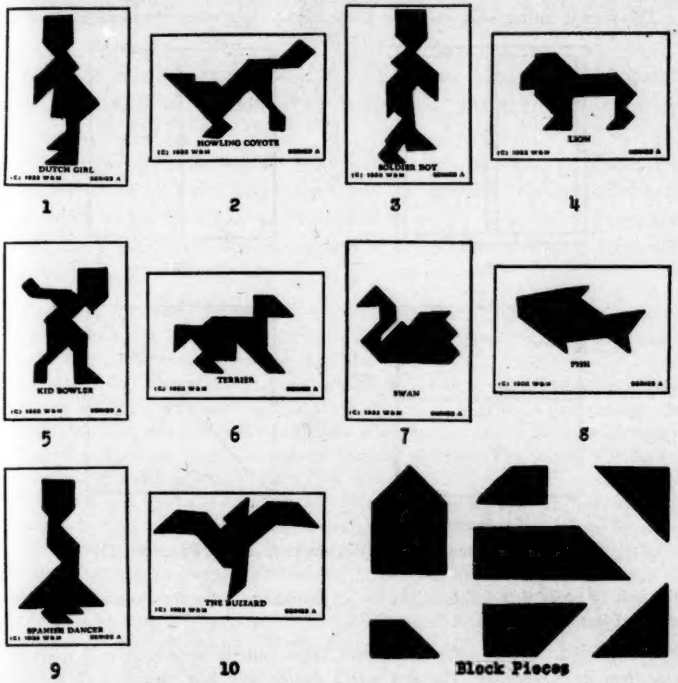

FIG. 2. SILHOUETTES USED IN PROBLEM II

The first step in the presentation was designed to encourage a detailed report on the foreperiod of action. To this end *O* sat just out of reach of figure and blocks (arranged in haphazard order on a table) but with a clear view. After an exposure of 10 sec., the figure and blocks were covered and *O* was instructed to report. Then *O* sat close, the cover was removed, and *O* continued the solution by manipulation.

[3] The silhouettes and blocks constitute simple puzzles of the parlor-game variety. The set is described as a silhouette problem game and is made by the American Record Corporation, Scranton, Pa.

After each of the ten silhouettes had been once solved, six of them were selected for repeated presentation. The procedure remained unchanged except for the fact that, as *O* became facile in finding the solution, the exposure-time was accordingly reduced. A maximal solving-time of 45 min. was allowed.

This problem was selected for its promise of (1) multiple and distinctive stages in learning, *i.e.* progressive functional changes, and (2) throwing into commission several functional aptitudes of the organism. The instructions follow:

Consider the objects to be shown here until I say 'now.' Then report in functional terms. . . . Carry out your task and report upon your procedure.

The formal instructions were not made explicit regarding the precise nature of

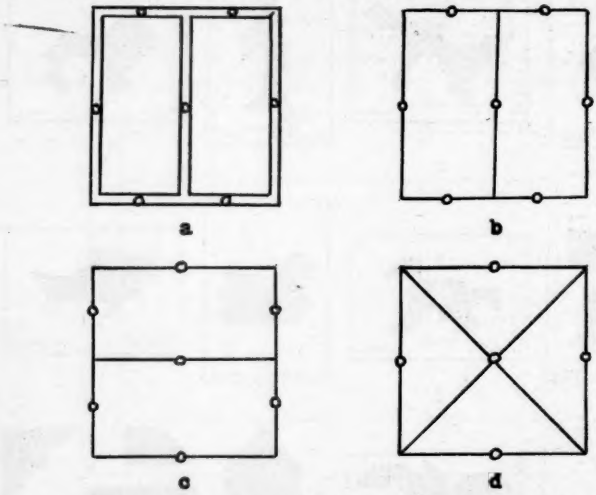

FIG. 3. APPARATUS AND PATTERNS USED IN PROBLEM III

the task in order that action might be set automatically by the occasion, *i.e.* by occasional instruction.

Problem III. Tracing reflected patterns. Three patterns were used, each more difficult than its predecessor. The first was a double line 3-in. square with a vertical dividing line down the middle (Fig. 3a). *O* was required merely to keep a moving pencil-point between the double lines. The second pattern was a square of the same size but single-lined. Here *O* was required to keep the moving pencil *on* the line. The dividing line was first placed vertically (b), then horizontally (c), through the middle of the square. The third pattern (d) was of the same size. The single line made a square divided diagonally in both directions. Again *O* was to trace on the lines.

The pencil was placed in the middle of the figure to provide *O* with an initial choice in direction. The task was arbitrarily fractionated by holes in the line. Here *O* rested his pencil while reporting.

Each design was presented to *O* seated at a table. The pattern was screened from direct vision but clearly visible in a mirror. *O*'s visual field was restricted to the pattern on its white background entirely surrounded by gray facings which eliminated visual apprehension of all other objects except the hand and fore-arm with which *O* worked. Each *O* used the right (preferred) hand.[4]

The instructions follow:

Take the pencil. When I say 'go,' proceed between (on) the guide-lines (line) until you come to a hole in the track. Leave your pencil there and report fully your procedure step by step. . . . Now go on to the next hole . . . the next hole . . . the place of beginning.

The Results

(A) The task. We first consider the rôle of task in the simpler forms of acting, the varieties of task, their origination, and their change under repetition.

The initial task commonly falls within the anticipatory phase, the prophetic phase of 'something-to-be-done' (balls rolled into cage, silhouette duplicated, or tracing followed from place to place). We consider here this initial task when formally set in verbal instruction or drawn from the occasion.

Problem I. Capturing rolling balls. The tasks are general, specific, and secondary.

(1) General task. The general task is an undetailed reference to a total and imminent problem. It may be definite or indefinite.

(a) Indefinite. The most undifferentiated form is only a vague formulation (*e.g.* 'a task is set'), the statement lacking all qualification. It appears (a) early in the series before adequate historical government is established to direct the performance, and usually disappears as soon as this government develops. (b) It may also appear later on in the series, especially when *O* is tired.

(b) Definite. A more elaborate general task is 'to get the balls in' or 'there are balls outside to be put inside the pen.' It indicates, in a general way, what is to be done. It may or may not be verbally formulated. Ordinarily it occurs late in the series after the establishment of historical government. It indicates familiarity and a degree of facility.

(2) Specific task. The specific task is a detailed reference to a phase of performance. It is set before resolution-by-movement occurs, and appears in an imprecise and an explicit form.

(a) Imprecise form. The imprecise tasks are definite with respect to what is to be done, but lack explicit formulation. They are 'get any one of the balls in' and 'capture one ball at a time.' They represent *O*'s acceptance of *E*'s problem in its simplest form, *i.e.* without the implication of captured-balls-to-be-retained-in-the-pen.

(b) Explicit form. In the explicit form *O* inspects a particular ball to create the actional determination 'get *that* ball in.' This is essentially a reformulation of the general task. *O* adds something to the original problem which was not included in the instructions.

[4] The observers for the experiment were J. D. Coakley (*Co*), M. L. Lemmon (*Le*), M. S. Ryan (*Sb*), and J. W. Macmillan (*Mc*), graduate students in psychology.

(3) Secondary task. The secondary task is a sub-task which occurs as a phase of the determination during the course of resolution. In this problem it is the most frequently set task and appears in the four forms: definite, indefinite, explicit, and elaborate.

(a) Indefinite. Like the indefinite general task this form is entirely unqualified. It is described as 'new task' or 'same task as before,' and it may occur at any point in the series. It chiefly appeared in reports of *Co* and in the middle of the series.

(b) Definite. This defines exactly what is to be done, *e.g.* 'roll a ball into position,' 'shake balls over and in,' 'return ball into cage,' or 'get them in by tilting less.' Occurring at any point in the series, it outnumbers any other specific form. *Co* is again the chief user.

(c) Explicit. Like the explicit specific task, but occurring only during resolution, it is secondary to a preceding task. It appears rarely because *O* comes to regard it as a restatement of task inimical to the formal instruction and thus as undesirable.

TABLE I

DISTRIBUTION OF GENERAL, SPECIFIC, AND SECONDARY TASKS IN TERMS OF THEIR APPEARANCE

O	General			Specific			Secondary					All tasks
	Ind.	Def.	Total	Imp.	Ex.	Total	Ind.	Def.	Ex.	Elab.	Total	
Co	4	2	6	1	2	3	14	48	9	1	72	81
Sh	—	8	8	1	3	4	1	5	3	3	12	24
Le	8	2	10	—	1	1	2	1	—	3	6	17
Mc	1	—	1	—	1	1	—	—	2	6	8	10
Totals	13	12	25	2	7	9	17	54	14	13	98	132

(d) Elaborate. Here the thing to be done is described more fully and precisely than in any of the previous forms, *e.g.* 'to capture one ball and to keep one or more inside the cage.' It is infrequent, although it most closely resembles *E*'s formal problem.

It appears that definite and indefinite *general* tasks were set with about equal frequency (13, 12); that *specific* tasks were least frequently set (9), while *secondary* tasks occurred most often (98). *Co* reported more than all the other *O*s together and eight times as many tasks as *Mc* (81, 10).[5]

Problem II. Dissected silhouette figures. The same kinds of task appeared, *i.e.* general, specific, and secondary.

(1) General task. The general task rarely appeared in the strictly indefinite form, though it did come as 'make whatever is there,' or (infrequently) 'to make (*e.g.*) the fish.' All *O*s reported the general task, albeit with variable frequency. It was unrestricted as to place in the series. *Co, Le,* and *Mc* set it late in the series; *Sh* early and late. Early in the series it again represents *O*'s initial lack of adequate historical government. Later historical government enables *O* to solve whatever pattern is presented.

(2) Specific task. The specific task, detailed reference to a part of the coming performance, appeared about as frequently as the general form. *Co* used it early in

[5] *Co* had a persistent SI to look for tasks. For standard abbreviations used in these studies see p. 224, above.

a given series; the other *O*s late. The difference derives from the varieties of specificity. These were four:

(a) Definite. (i) To place the known pieces. When *O* inspected a given block or combination of blocks as a given part of the 'silhouette' he tended to place those blocks first. *Co* definitely set this placing of known pieces as a specific task. It represents his most common form. Identification of some block or combination of blocks as a given part of the pattern appeared early. Therefore an *O* who set a task to place these identified blocks first would naturally report specific tasks early in a series. (ii) To find the position of a 'key-block' is another definite, specific task and requires the recognition of the precise position of one block in the pattern. It represented a clue (comprehending part-task) for placing other blocks (latter stages of solution). When the outlined pattern of the model clearly indicated the position of (*e.g.*) the large trapezoid, that block was placed immediately. If, however, the pattern gave *no indication* of the place for this block, *O* then searched for its right

TABLE II

DISTRIBUTION OF GENERAL, SPECIFIC, AND SECONDARY TASKS IN THE ACTIONAL COURSE

O	Foreperiod				Midperiod				Undetermined				All tasks
	Gen.	Sp.	Sec.	Total	Gen.	Sp.	Sec.	Total	Gen.	Sp.	Sec.	Total	
Co	15	1	—	16	4	16	30	50	—	—	—	—	66
Le	14	6	—	20	5	4	4	13	1	1	—	2	35
Sh	3	3	—	6	—	2	6	8	—	1	—	1	15
Mc	3	—	—	3	5	5	3	13	2	—	—	2	18
Totals	35	10		45	14	27	43	84	3	2		5	134

place. Hence the task narrowed to the site in the block figure and this became the crux of the solution. To find its hidden position required more acquaintance with the given pattern than to find its obvious place. When *O* set this task (to place the key-block) he naturally tended to report it after several repetitions of the pattern.

(b) Indefinite. (i) Whenever an unqualified statement of the specific task appeared, it was late in the series and was formulated as 'task has become specific' or 'there is a slight task left.' It represents an abbreviated form which appeared as a result of familiarity with the problem. (ii) To make the block-pattern without looking at the silhouette was an explicit task which occasionally appeared late in the series. It was never set by *Co* whose specific tasks appeared early, and was discouraged by *E* as undesirable because it changed the problem.

(3) Secondary task. The secondary task, *i.e.* the task set as a phase of the determination during the course of resolution, appeared only in the early members of a series. It was set with greatest frequency by *Co*. Just as soon as *O* had so stabilized his determination that the method of duplicating any given block-pattern ran itself off from the apprehension of the pattern-to-be-duplicated, he had no further need for secondary tasks. Since this series tended to a progressive stabilization of method and ligation of movements, there was finally a complete elimination of secondary tasks.

In this problem, foreperiod was definitely separated from the rest of the acting. The table above indicates the distribution of these three kinds of task in terms of their appearance in the foreperiod and midperiod. One-third of all the tasks are

set preliminarily while *O* is looking at (but not handling) the material. About three-fourths of all (35) *general* tasks are set here. In the early stages of the midperiod, the same fraction of *specific* tasks (27) are set under manipulation.

This problem illustrates more clearly than the others the temporal development of the task. The general task may be set as *O* enters the experimental room, while a very specific task sometimes appears as *O* draws his chair to the table at the completion of his preliminary report. Examples of change from general to specific follow:

[Away from table] task ("make"). [About as general as when called to observe. While table was being rearranged] > task ("make whatever is there"). *Co*-II-3, 7[a]

["Task grows out of the preliminary report occasionally; more often it takes form as I give the report, and most often as I move the chair up to the table."] *Co*-II-4, 3

In_P (fish) > SI (look at the bottom part of tail). [Card removed] In_P (girl); In_P (skirt) > In_m (those three lines . . . making point in center of skirt, square end of short piece makes waist, triangle goes on the bottom, little piece in front). [Card replaced during report: now] task becomes (put the skirt together . . .). [Chair drawn up; card removed]. Act (placing these three pieces . . .) *Le*-II-1, 6

In_P (fish) > S_{Im} (triangle in place) > SI (get little piece for bottom of tail) > S_{Im} (how it would go). [Cover removed]; S_P (bottom of the tail). [Setting task as] > com ("get busy now and put it together"). [Card replaced; chair moved up]; task (do it without looking at silh) S_{Im} (two pieces in front) + A_{Im} (myself putting them there). [Card removed again] > (placing head, body, and tail) . . . *Le*-II-8, 6.

In_P (familiar lion) > [very brief] > (of front) > A_P (way the big block fits). [Card replaced] A_P (of that block in position) > task (to place that block). [Chair moved up to table, cover removed]. A_P (block in position) > (placing the big block) . . . *Sb*-II-4, 6

The distribution of times when the task emerges was reported in general by *O* to follow a given pattern. First, setting of the general task (to make whatever is there) [before the pattern was uncovered]. The next stage followed the apprehension of the uncovered pattern. Here the task was to 'make the thing.' The third stage may occur while *O* was still sitting out of reach of the blocks. This task was to 'make it this way.' The last stage appeared as *O* handled the blocks. It was the specific command 'to make the block-pattern by placing each block in a now-determined precise relation to every other block.' Although all of these steps were not always reportable, the account of a fairly fixed temporal ordering of the various kinds of task suggests that the common terms 'attitude' and 'set' may sometimes be explained by such a sequence of tasks.

Problem III. Tracing reflected patterns. Again the same three forms of task are reported; general, specific, and secondary.

[a] Only pertinent excerpts from protocols are cited. The key at the end of the excerpt identifies it, *e.g.* (*Co*-II-3, 7) Coakley, second problem, third silhouette, 7th presentation. Square brackets enclose supplementary remarks. The parenthesis following the name of the function contains the functional product.

(1) General task. The general task (undetailed reference to the total problem) occurs again in two forms, definite and indefinite.

(a) Indefinite. The most indefinite is, as before, a vaguely formulated demand (*e.g.* 'do as told') or an unqualified statement that a general task is set. The same conditions appear to hold as were found before, *i.e.* task either appears early in the series (before adequate historical government is established) or later in the series (when other tasks are wanting and the organism requires an omnibus prompting).

(b) Definite. A more elaborate general task is to 'move around the square' or to 'steer the pencil.' This differs from the indefinite form in that it indicates in a general way what is to be done. Ordinarily it occurs late in the series, after the establishment of an historical government. Then it implies that *O* is *au courant* with the business of the moment.

There is, besides, a refinement of the general task which approaches the specific form. Such a task as 'I must take the pencil and start' is definite with respect to taking the pencil, but remains indefinite with respect to direction and procedure. This intermediate form may appear at any point within the series (not at the very

TABLE III

TRACING PROBLEM: DISTRIBUTION OF TASKS AMONG OBSERVERS

O	General			Specific			Secondary			All tasks
	Indef.	Def.	Total	Indef.	Def.	Total	Indef.	Def.	Total	
Co	14	9	23	89	37	126	7	1	8	157
Sh	3	—	3	45	22	67	4	—	4	74
Mc	—	3	3	—	6	6	—	—	—	9
Le	2	1	3	—	3	3	—	—	—	6
Totals	19	13	32	134	68	202	11	1	12	246

beginning). It usually indicates a foreshortening of a more general task, with which *O* is now familiar. It serves the purpose of throwing organic resources into commission.

(2) Specific task. The specific task, as already defined, is a task in which there is a detailed reference to a prospective phase of performance. It is set before resolution-by-movement occurs, and appears either in a definite or an indefinite form.

(a) Indefinite. This most often appears as an unqualified statement that a specific task is set. It takes such forms as 'move along the line' or 'do it as last time.' The unqualified form is by far the most prevalent for two *O*s. Its presence indicates a recognition of demand, while its absence may indicate either that the demand was unrecognized or was overlooked.

(b) Definite. The definite form of a specific task is usually 'go to *that* hole,' 'move to the next hole,' or 'go back to the beginning.' It was used by all our *O*s and apparently represents acceptance of the formal instructions in the same way as the second kind of the general task represented *Co*'s acceptance of *E*'s problem. This definite description was usually made early in a series. Later there was a tendency for it to drop out and to be replaced by the less detailed, indefinite, specific task described above; *i.e.* instead of setting a task to 'do the first part' or to 'go on to the next hole' (as occurred at first) there appeared the substituted form, 'the task is set' or 'go on as before.' Specific tasks were set most frequently by *Co* and *Sh*. *Le* and *Mc* rarely formulated them; in fact they set far fewer tasks than the others.

(3) Secondary task. The secondary task was infrequent in this problem. It requires no further comment. Table III summarizes the distribution of tasks by observers.

The problems compared. We have found that general, specific, and secondary tasks are set in all three problems. Let us examine them all together to discover the conditions for their arousal and the changes which they suffer under repetition.

In the first and third problems the task is approached by formal instruction. In the second it arises from an inspection of the materials and is set from the occasion or by a self-instruction. Revision, reinstatement, or fractionation of the task occurs under the influence of the products of a psychologically active organism.

In the silhouette problem is found the clearest example of a psychological product which serves in task-setting; the fruits of inspection leading to a task. Thus, the occasion calls out a task before the pieces are handled or movement induced. Fuller inspectional, comprehending, and imaginational operations forecast an arrangement of the blocks.

In_P (pieces and pattern) > comp (task) > In_P (pattern) + In_P (pieces) A_{Im} (placing long piece) *Le*-II-1

OI set actional task > A_P + comp (leo) > A_{Im} + A_{In} (completely divided pattern into blocks [except hind legs and body]) *Co*-II-4, 2

Per (blocks) > insp (blocks) > com ("sides of some blocks would fit together") > per (white card with black figure) > insp (card) > com ("oh, that's what they make") > A_P (objects) + A_{In} (sorting them out to make silh) > A_{Im} (matching objects and pattern) *Mc*-II-1

OI set task > A_P + com ("a hard one") > SI (get busy) > A_{In} + A_{Im} (figure breaks down into block shapes) *Sb*-II-5

Over and beyond these functional specialties, called for by the broad use of the 'occasion' in the silhouette study, the general forms of task were much the same in all three problems. Variety and lability, shown all through the process of 'tasking,' indicate the versatility and the resourcefulness of the organism making use of such outcomes to redirect, to modify, and to advance the actional course toward its final goal.

A fair scrutiny of the facts of report makes it evident that the bare account of bodily movement as 'response' to a 'stimulus' quite overlooks the essence of this rich variety in psychological performance. The notion of an unvarying 'stimulus' as inducing an unvarying 'response' leaves out of account the central and highly variable part played dexterously by the organism, where a repeated stimulus seems to the superficial observer merely to lead on to one and the same responsive type of movement of capturing balls, duplicating an outline figure, or retracing a linear pattern.

Our most important phase of the comparison still remains. It concerns the modifications of the task under repetition from the first to the last

member of the series of actional performances. This progressive change has now to be described.

In capturing rolling balls the trend in modification was as follows. Either a general or a secondary task was set at first. After a few repetitions the general task dropped out and the secondary persisted. After many repetitions there is, as a rule, no task remaining. Rarely a general task may reappear or a secondary task persist. Excerpts from *Sh's* reports represent this trend. (They are taken from the 1st, 4th, 12th, and 16th reports.)

1st	balls outside are to be put inside	(general)
4th	task to keep three in and capture fourth	(secondary)
12th	same task as before	(secondary)
16th	to capture one and retain three	(secondary)

In duplicating the silhouette figures, the trend in modification was somewhat different. All three kinds of task may occur at first. After a few repetitions, general and specific drop out, while the secondary may persist. After more repetitions, there is ordinarily no task; rarely a general or a specific task may reappear. Excerpts from *Le's* reports are selected to illustrate this trend (first pattern in 1st, 3rd, 6th, and 8th presentations).

1st	pieces are to be fitted into a pattern	(general)
3rd	to make the skirt from these three pieces	(secondary)
6th	to put the skirt together	(specific)
8th	no task reported	

In tracing linear patterns the trend is almost the same as in the preceding problem. The difference lies in the fact that more specific than secondary tasks tend to survive the first few repetitions. Excerpts from *Co's* reports taken from the 1st, 2nd, 8th, and 14th presentations of the first pattern are typical:

1st	do as told	(general)
2nd	go same way	(general)
8th	go to that hole	(specific)
14th	specific task set [to follow previously determined direction]	(specific)

Although any given task may be set at any given point in a series, there is a tendency for a task to be set in the early members of a series, and for it to undergo change, abbreviation, and elimination under repetition.

Summary. Under the conditions of this study *O* set a number of tasks either as a result of formal or other instruction. The tasks were revived, remodeled, or extinguished under repeated presentation of the given situation.

(B) The course of determination. Beyond the task, acting demands a provision for appropriate resolution. That is to say that acting is 'determined.' The 'determination' is the previsory stage of acting. Sometimes it

is carried through in the form of physiological functions only; sometimes the psychological moments of searching, perceiving, imagining, and so on, appear. At times determining is directly provided for by historical means of government. In such a case there may be little that is reportable, a flashing task flowing rapidly to a neuromuscular resolution. But where the situation is novel, abrupt, or complex, the determination may be developed from the products of apprehending and other functions in course, search usually appearing and tending toward goal or outcome.

The determinational phase represents the going-on-ness of the operation. On those occasions when it does not directly affect psychological functioning, it may be announced indirectly through an accidental interruption, as when *O* overshoots the marks while capturing balls, 'automatically' bringing back the ball to a prearranged starting point, or when a linear tracing takes the pencil beyond a turn.

In developing determination out of task, the organism employs much the same inducing and guiding factors as accompany the fully established performance. These will appear in instances which follow.

Problem I. 'Capturing.' Evidence of determination sometimes appears in *O*'s first report. *Sh* reports a flash 'tip the box this way and the balls come to this end; tip it the other way and they go in.' She elaborates this through anticipative comprehension that, with one ball captured, the tipping must be altered to prevent its escape. *Co* develops (comprehending) the most advantageous position for the balls, anticipating their movement to reach it and their subsequent movements to be rolled into the pen. *Le* begins in an exploratory manner to roll balls around in the box in order to ascertain how many go in with random movements, and then immediately refines the neuromuscular coördination to retain the captured balls. Setting of task is directly followed by movement accompanied by 'apprehension of eye and hand coordinations necessary to accomplish this' (*Mc*-I-1).

Each of these represents a prophetic anticipation of movement supplemented by comprehending, or by manipulative searching out, of the possibilities. The functional witnesses of determining tend to lapse under repetition.

Problem II. Silhouettes. In these figures the development of the determination is clearly marked by psychological moments in course. The preliminary period (when *O* observes, without handling, the material) made possible an amplified report of this development. The following examples are taken from this initial period.

A_{in} (this piece for head) > S (what for arms and body?) > A_{in} (pieces and silh) > com ("this piece will do") > A_s (what for feet?) > A_{in} (pieces) > com ("these will do") *Sh*-II-1a, 1

A_p (familiar bowler) > A_{in} (position of all block-pieces identified in silh) > com ("this ought to be very easy; just place the pieces as I see them") *Le*-II-5a, 4

A_p (fish and blocks) > S_{im} (correct location of key block) + com ("I can put that together in no time") *Co*-II-8a, 2

A_p (blocks) > A_c (pattern) > A_{in} (pattern divided into block shapes) *Mc*-II-4a, 1

Searching toward goal or outcome is evident in the first and third examples above, while in the second and fourth *O* anticipates no difficulties in the outcome.

Problem III. Tracings. For three *O*s the novelty of this situation was only in the particular pattern presented. (Since *Co* had never attempted mirror drawing, the situation was novel.) The problem provides an intermediate step for the development of determination between the completely novel situation of the preceding problem and the more obvious procedure of the first. Excerpts follow showing the presence of historical government, for *O* draws generously upon past experience in developing the determination.

A_p (familiar situation) $>$ A_c (this will be just the opposite from the way it looks) $>$ A_c (easier to go forward in the mirror) $>$ A_{im} (two contiguous patterns) $+$ $Comp_a$ (If I want to get to that part I move the pencil away, but it will appear as if coming toward me) $>$ $comp_a$ (at that point . . . there is no left-right reversal) *Le*-IIIa-1

$Comp_a$ (this is mirror drawing and I should go in the opposite direction from the one I think I should) *Sb*-IIIa-1

For the *O* unfamiliar with mirror-drawing, historical factors also contribute to the development of a determination.

A_p (the situation) $+$ A_{in} (the pattern) $>$ $comp_a$ (principle of bending light rays): A_{in} (pencil in hole) $>$ A_c (two ways to start; either follows FI) $+$ A_p (track to corner) . . . *Co*-IIIa-1

The problems compared. We have found determination arising out of task in each of our problems. The course of its modification as the acting is carried through time after time is now to be considered.

With repetition the determination becomes a fixed and relatively invariable rule with little that is reportable. Where it is reported, it may be in symbolic form as 'follow the system' or 'always turn right.' Hints, too, are gleaned from comments on how things are getting on.

In subsequent repetitions of ball capturing, *O* modified his performance in accord with exigencies of the occasion. These modifications, however, were incidental to an established procedure. In the following reports a typical determination is developed.

> task to be resolved by aiming balls from opp end of box *Mc*-I-1
> edge balls in without using extra space *Mc*-I-2
> tap box to shoot ball in *Mc*-I-5
> edge them in from side [*i.e.* roll balls forward around cage and in] *Mc*-I-6

The fourth example above is essentially the same as the second. It represents a return to a former performance, which is, from here on, adhered to throughout the rest of the series. When mentioned, it is referred to as 'the system.'

Determination was least reportable in the linear tracings. Evidence of it appeared when *O* began tracing with the 'ready' signal instead of waiting for the 'go.' In the following excerpts are hints of determining in the comments and accompanying factors.

A_p (set-up) $>$ com ("something different this time") $>$ com ("it's the same thing rotated 90°") . . . *Mc*-IIIc-1

A_p (pencil moving around corner and off line) $>$ com ("I don't see what is the matter with me today; maybe it's sleepiness") . . . *Mc*-IIIc-3

A_p (pencil moving on line): [at corner a change in movt and pause, a muscular set for dash to goal] > movt to goal *Mc*-III*c*-8

The comments in the first example above imply that, after all, the new pattern changes little. The comment in the second example implies a slump in performances, while the appended remark of the last example refers to the neuromuscular mechanism for carrying through the appropriate movements.

In the first pattern of the third problem, *Sh* and *Co* set rules always to trace the line in the same direction. Subsequent patterns were traced in the same way without report on this fixed procedure. Its presence was ascertained from remarks subsidiary to the reports.

In the silhouette problem, however, there is definite evidence of a development of the determination. With repetition the novelty of the pattern wore off and evidence of the modification accrued with succeeding reports. The following excerpts from the reports of *Le* are representative.

A_p (familiar figure) > M_a (have done it before) . . . A_{1a} (positions of head and arm blocks located in silhouette) > A_{1a} (position of skirt pieces unidentified) > A_{1m} (position of one skirt piece) *Le*-II-1a, 2

A_p (familiar figure) > A_{1a} (positions of head, arm and feet blocks identified) > per (skirt blocks unidentified) > A_m (having trouble with this before) *Le*-II-1a, 3

A_{1a} (familiar pattern with prominent skirt) > A_{1a} (skirt blocks identified) *Le*-II-1a, 7

In the first example above, the determination is unresolved; no solution is reached. The unidentified pieces are obstacles to rapid and accurate resolution. In the second, four of the seven blocks are identified in their proper positions. Here is an implied forecast of the appearance of the field when movement has altered it. The last example represents an abbreviated determination. The difficult part is now solved; the rest ignored. The movement following is carried through rapidly and without error.

Summary. Determination was definitely developed out of task in the silhouette problem, reported in the ball-capturing, and present in linear tracings. Under repetition it became changed, abbreviated, and eliminated from report. It was supplemented by the inducing and guiding factors accompanying the established performance. These factors are now to be considered.

(C) Accessory factors. In addition to the directive agencies guiding the organism toward resolution, there are certain factors which are accessory. They appear as commentaries, in terms of (verbal) comment, or non-verbal flashes and functional incidents. They are not 'determined' in the sense of forecasting, but they are integral to the course and refer to the present phase of the acting. They appear throughout the problems and may or may not be modified under repetition. Again, these incidents may serve as occasional hints; *i.e.* they are ostensibly accessory and accompanying factors, yet they

appear to induce turns in the operation. A few examples of these accessories may clarify their position in the actional course.

Problem I. Capturing. Every *O* reported accessory factors in this exercise. They appeared unchanged by repetition. Occasionally they indicated a slight emotional coloring to the performance, *e.g.* when the situation became predicamentive because *O* set an inappropriate task.

A_P (balls not going in). [Am tense trying to lower my own time. Feel hurried and impatient because I am slow; could speed up if I could overcome this feeling] *Mc*-I-6

Fl (ball in) . . . fl (ball in) . . . fl (ball in) . . . *Mc*-I-25

A_{com} ("box-as-something-I-had-to-tilt") > com ("I'm sick of this") . . . *Sh*-I-11

Per (course of movement) > fl (balls are in position to start) . . . fl (ball is not rolling straight) *Le*-I-24

Per (ball is in position) + P_a (captured balls are rolling) . . . *Co*-I-14

Above are examples of accessory factors. Where the balls are 'in position,' the 'position' represents something selected and something expected. The performance in the first and third items has an affective coloring with intrusion of the self-object.

Problem II. Silhouettes. Every *O* reported accessory factors which became minimized under repetition. Comments dropped out and the non-verbal flashes and functional incidents were reduced to a perceptive accompaniment of the resolution.

Com ("it's the old woman") > A_{im} (Alice in Wonderland) > com ("it looks like the red queen") . . . *Mc*-II-3a, 2

Per (block) > placing it > A_P (next block) > placing it > A_P (next block) > placing it > A_P (next block) > placing it > com ("that's done") *Mc*-II-3b, 8

A_{in} (silh) > A_c (this block must be the head) > [movt of placing it] > fl (this for arm) > [movt] > fl (this makes body) > [movt] *Sh*-II-5b, 2

[Movt of placing the blocks guided by] > A_P (silh) *Sh*-II-5b, 6

The accessories do not entirely drop out but they are modified by inclusion and stabilized by repetition. The inclusion comes as an elaboration of the perceived object. The block in a given position—as head, arm, body, and so on—serves as occasional instruction for position of other blocks.

Problem III. Tracings. Accessory factors were reported by each *O* in this problem also and these incidents tended toward elimination and stabilization under repetition. They occurred as A_P (end of lane), (missed hole), and A_m (this turn I recall as easy), and they accompanied without forecasting. After several repetitions they were supplemented by the accompaniment [movement +] A_P (of-the-course-I-am-taking).

The problems compared. In each of the exercises these accessory factors appeared and became stabilized or largely eliminated under repetition. Finally they appeared almost entirely in the form of a perceptive accompaniment to the smooth resolution.

There were also self-instructions bearing upon the operation in terms of admonitions to do better, or to go more carefully or accurately. These were more plentiful in capturing the balls and tracing the lines than they were in duplicating the silhouettes.

More comments appeared than have been represented in the examples selected. They were indicative of the status of the performance at any given moment as, com ("one of the balls must have come out"), com ("are there enough pieces?"), and com ("it is better to keep moving than to go back").

Summary. Accessory factors are present but tend to drop out or stabilize under repetition. Some of these factors (*e.g.* comments) have been accepted in some studies as important evidence of developing skill and together with descriptive accounts of changing movement (behavior) supply the central material for mechanistic accounts of 'learning.' We turn now to a brief account of the motor phase as it changed in this study.

(D) The motor phase of acting. The displacement of balls, blocks, and pencil-point forms, in these three problems, a part of the resolutional stage. These object-movements, their immediate antecedents, their sequels, and their remodelling under repetition, are now to be considered. Evidence has come in part from *O* and in part from *E*.

Problem I. Capturing. Early reports in the series include tipping, shaking and tapping the box, using both gross and fine movements. After more repetitions, the most effective means is settled upon, neuromuscular digressions eliminated, and the whole operation refined and stabilized. An early instance is:

A_E [task] > fl [determination] > movt + A_P: [one ball in cage alters determination] > movt + A_P > movt + A_P > fl (did not tip enough) . . . SI (be more careful) *Sh*-I-1

Two *O*s developed consistent and effective movement-patterns stabilized in later instances with almost no determination or anticipation (*e.g.* 14, 21 below).

SI (start from corner) > [movt] insp (so one rolls down side) > insp (ball in opp corner) > SI (move ball to gate) > com ("oh, it rolled in"): SI (roll ball gently down side) > movt > fl (in) + com ("there"): SI (start from corner) > insp (ball rolling down side) > SI (tip gently) > insp (ball in place) > SI (be more gentle and roll it quietly) > insp (ball sticking at side) > fl (in): SI (put ball in corner) > SI (run it down side) > SI (watch balls inside) > fl (ball at edge) . . . imag (ball going in) > fl (ball in) > com ("there") *Mc*-I-21

Per (ball) + com ("right position") > SI (tip to right) > SI (tip forward) > com ("just this one") > per (ball opp gate) > OI (tipping left) > fl (one in) > OI for movt (getting others in posn) > SI (tip to right) > SI (tip forward) > per (ball opp gate) > OI for movt (tipping left) > fl (in) > OI (get others in) . . . *Le*-I-14

As the performance was run through time after time, *E* observed an increase in *O*'s facility in manipulation. Gross movements became refined, more capturing of the balls was carried through to completion, balls seldom escaped, and posture and movement became invariable and prompt.

Problem II. Silhouettes. Every *O* reported two kinds of movement, directed-tentative and undirected.

(1) Directed-tentative. Tentative movements appeared from the first trial under antecedent determination. They were guided by OI and led to a change in position of a given block. Later the tentative movements became prompt and unequivocal.

They are revealed by queries and the uncertainty of their antecedents and by the discarding or modifying of their sequels.

(2) Undirected. Undirected movements sometimes accompanied, then directed, search. They were reported as 'random' or 'just trying.' *O* was baffled: productive functioning was at a standstill. *O* resorted to undirected movements in the hope (searching determination) that a chance combination might serve as OI to resolution. This disappeared after about five repetitions.

Fitting the blocks together to duplicate a pattern depends upon the fact that *O* comprehends that any given block stands in but one particular relation to every other block in any given pattern. The outcome of inspecting is 'the position of that block is known' or 'I will place the known blocks first' (comment or flash). Lacking this moment of 'knowing,' the random movements appear.

In attempting to duplicate the silhouettes, *O* shifted the blocks many times and made many combinations. Old combinations also reappeared after being discarded. By the last (8th) presentation of each silhouette, movements were direct and precise, ligated into a stabilized pattern.

The oft-repeated movements might have been observed and described by *E* as random or 'trial and error' attempts, but *O*'s reports show that only a small number of them were really undirected and indeterminate. Besides, 'trial and error' is not descriptive of *O*'s actional course. It is a theoretical explanation from *E*'s observation and needs the check of reported functional flow.

Problem III. Tracings. Separate, non-ligated movements with discrete antecedents and sequels were at first reported by every *O* on each of the four designs. Presently the movements became ligated. Digressions from the line never drop out entirely (except in one pattern) but become ligated into the movement-in-progress. The following excerpt demonstrates the presence of object-movements with their immediate antecedents and sequels.

SI (go same way and get accustomed to it) > movt [at corner, lapse of function].
OI (for movt) > per (crooked line) > OI (movt) *Co*-IIIa-2

E observed at times an initial hesitancy and fumbling in starting early trials. Jerky movements marked indecision at corners, and inability to progress directly to the goal were also noted in early attempts to trace the patterns. With time, however, these characteristics were eliminated. After a few repetitions, *O* started promptly, digressed less, eliminated hesitancy at the corners, and finally drew a smooth line from beginning to end.

The problems compared. The ball-rolling supplied the clearest example of a movement-pattern. It was not so clear in the other two problems for the reason that more digressions were possible. Nevertheless, it was implied in the relatively frequent report of successive placement of blocks in an orderly fashion from head to foot. There was a tendency toward patterning in the two *O*s who made the rule always to trace the designs in the same direction, but the inevitable digressions in the course of tracing tended to keep the performance labile so that it approached a pattern only after several repetitions, when the digressions became included in the course of the movement.

The silhouettes brought out the distinction between tentatively directed and undirected movements. Although the undirected or indeterminate movements may have occurred in the other two problems, they were not so definitely reported. The final, unequivocal movement found in the silhouettes was not attained in the other problems because *O*'s control of the situation was less complete. That is to say, there was always opportunity for balls to roll in a relatively unpredicted direction, and digressions of the pencil from the line were never entirely eliminated. But once position of a block in its precise relation to every other block in any given silhouette figure was 'learned,' placing the block was unequivocal.

Continuity of movement and function develops from discrete phases of object-movements with their antecedents and sequels in each problem, but perhaps it is most clearly observed in the linear tracings. Here the performance may be finally reported as 'movement in one continuous sweep accompanied by perceiving the course of the line.'

Summary. Ligation, stabilization, elimination, and inclusion all appear in the motor phase of acting. Movement-pattern may develop. 'Random' activity rarely occurs.

Summary of Results

The task, determination, accessory factors, and motor phase heretofore described in some detail must now be brought together into a consideration of the entire integrated functional course of the action. The essential changes found to occur under repetition must be summed up and briefly presented all together. The entire integrated course, which includes the prophetic anticipation of something-to-be-done, the forecasting of, and providing for, accomplishment through movement, has been described, phase by phase, in each of the three problems of this study. We recapitulate in order.

Problem I. Capturing. Appearance of the successive phases of acting was facilitated by the natural subdivision of the problem into the capture one by one of the individual balls. *O* sometimes established a general task covering the entire performance of caging all four balls: sometimes he set a specific task bearing upon the penning up of a single ball. It was possible for the determination to follow as a flash directly from the task or to develop by degrees out of the demands of the task. Often no functional representation of determining was reported. There appeared also an intermediate stage wherein both task and determination were monophasic. The motor stage with its preceding and succeeding moments, forming the central part of the resolution, also came to be telescoped and abbreviated. Accessory factors were present throughout the early execution of a given performance, but after several repetitions these were usually reported in terms of a generalized and undetailed perceiving

coincident with the movement. Typical reports of an entire action are given below in standardized form.

A_e specific task (to get this ball in) > A_{in} (possible courses) > A_{in} (tipping box and following course of ball) > A_p (getting ball in): A_e (task same) > A_p (course of ball) + [with occasional reference to captured ball]: A_p (task, next ball) > [no specific plan—formulated from occasion] > fl (ball did not roll in): A_e (task) > A_p (ball rolling in) *Co*-I-7

In the above report the performance is not yet integrated. Capturing each ball represents a unit within the whole.

The following report is of a much more highly integrated performance which flows on from inception to conclusion.

A_e (task to get them in by rolling as before) > A_p (one at edge of pen) > SI (go slowly) > fl (one in) > OI (tilt) > A_p (one on edge of pen) > SI (go slowly) > fl (in) > OI (tilt) > A_p (balls rolling around pen) > SI (do something else; they won't ever go in this way) > tilting more but slower > fl (one in) > OI (tilt) > tilting > A_p (other ball in) + fl (that's all) *Sh*-I-14

Problem II. Silhouettes. The same phases appeared in this series and underwent by repetition similar modifications. Although *O* was provided with more freedom in setting this task, his formulations were nevertheless classifiable into general, specific and secondary. In the well-isolated preliminary period (when *O* considered, without handling, the blocks) the development of determination was most clearly demonstrated. That abbreviation or substitution of a part for the entire determining phase may occur was also demonstrated in this previsory period. Ligation and stabilization of the motor phase occurred unevenly. That is to say, the precise spatial relations of a few blocks in any given pattern were established more rapidly than the position of other blocks. But finally a complete ligation did appear. Accessory factors were present at all times. Under repetition they became fewer and fewer and the commentaries took the form of perceptive accompaniments to the main operation in course. A representative report is cited here in full to demonstrate the entire integrated course in this problem. Preliminary scanning (a) and execution (b) are distinguished.

(a) comp (task) + SI (insp the pattern to see what you can imag) > comp (silh) > imag (where trapezoid is to go) > insp (very thin part of arm) > com_a. ("oh, yes, that is done by overlapping two pieces as I've done before") > insp (ankle) > com ("oh yes, the same") > SI (try to visualize the lines dividing it into pieces). [Determin. incomplete at end of 10 sec.: material covered; report given; chair moved up; material uncovered.]

(b) SI (look these things over carefully before placing them) > A_{in} (hand is small and will be one of the little pieces) > (placing it) > $A_{p\ and\ e}$ (head goes here) > (placing it) > SI (figure out where the long piece goes) > A_{im} (its position) > (placing it) . . . com ("this is right") > SI (see that relative positions are right) + fl (that's right) *Le*-II-5, 1

In this report the task was assumed and implied in the SI. The developing determination is relatively elaborate but incomplete in the first period.

Problem III. Tracing. Tasking in this exercise appeared, as before, in general, specific, and secondary forms. Like the first problem, again, this had moments of task and determination combined in the same functional phase. Determination was less fully reported in this problem than in Problems I and II, but hints of its presence were plentiful. Antecedents and sequels of the motor phase were somewhat

more frequently reported. Accessory factors were also numerous. A typical report follows.

Insp + comp (FI and OI set task) > FI (go) > (movt) > com ("go carefully") > (movt) + A_P (pencil point on the line all the time) > com ("good for you; that is the best you have done"): com OI + FI (set task) > SI as com ("do as well on this part) > (movt guided by) > $A_{P\ and\ s}$ (line-where-I'm-about-to-go; line-I'm-drawing) > comp (not doing so well as before) > OI (go faster) > SI (don't spoil it) (> movt slowed down): FI (go) > (movt) > A_P (line-as-about-to-be) *Sb*-IIIb-2

The above report includes the setting of a secondary task, as well as of an unspecified initial task. Hints of the determination come out in the accessory factors, which are present to the end; antecedents and sequels of the motor phase are also represented.

Repetition was found variously to affect each of the phases in course. Changes were in the direction of (1) elaboration and in the direction of (2) abbreviation, of (3) inclusion and of (4) elimination. (5) Ligation and (6) stabilization also marked the total course. Modifications were greater in some parts than in others and were also more clearly described in some problems than in others.

Elaboration of *task* occurred in the setting of secondary tasks during resolution. The general initial task especially called for subdivision and recasting to attain a satisfactory resolution. Elaboration was also apparent in the intermediate stage, when determination was released. Here new and detailed directions for resolution were profitable, *e.g.* 'go around to the right carefully and keep the pencil-point on the line.' Here task lasts over into the determining phase.

The task was at all times fairly well ligated to the rest of the performance in the first and third problems, while the second exercise brought out a progressive and developing ligation between the two parts. That is to say that, in the first presentations of the silhouettes, the developing determination—often incomplete—separated task from resolution in a manner not observed in later repetitions, when task 'to make this thing' flowed directly into determination with every following movement forecast. Very early in the serial performance of each exercise the task became stable and fixed.

The *determination* went through a special form of elaboration in the silhouette series. Subsequent abbreviation appeared when, after a few repetitions, the reported determination provided the means for solving one part of the figure only. Elimination of the determining phase was only apparent. Often it went unreported, but its presence was announced in the travel of the pencil beyond the turn or the unannounced returning of stray balls. Unfortunately we still know little of the neurology of Ach's 'deter-

mining tendency,' although recent recording of neuromuscular potentials is a safe and useful indicator of its presence. Progressive smoothing and stabilizing of this phase appear when searching was replaced by perceptive and inspectional moments.

Changes in the *motor phase,* with its antecedents and sequels, occurred after the first repetitions of a performance, where many slips, errors, or false movements came in. As these were eliminated, this aspect was abbreviated, consolidated, and made precise.

The *accessory factors* are rarely elaborated but sometimes condensed under repetition. Their ligation to the rest of the operation appears unaffected by repetition: they are parenthetical accompaniments tied into the operation at any point with little affect upon the main course. Where they do come in they appear as moments in, or comments upon, the determination.

A careful comparison of reports selected from various temporal places has revealed typical progressive changes from trial to trial and from week to week. The most salient of these functional modifications are (1) the elimination of task, (2) elaboration followed by abbreviation of determination, (3) gradual diminution of accessory factors, and (4) final ligation of the whole operation into a rapid and accurate performance. Such modifications in course under repetition we have regarded as 'learning,' a term which more commonly implies gain or accomplishment of a useful sort. In this more uncritical sense, learning is inferred from reduced times, decreased errors, increased skill, or performance without a model and pattern, as in 'nonsense' learning. It therefore obviously deals with end-results and products. It does not attempt to describe the fundamental processes by which 'acquisition' is made possible. This description has been our chief aim and concern.

With allowances made for differences of task (memorizing and manipulating) and the resulting determination, as between Freeman's research and ours,[7] we may say that approximately the same pattern of change and remodeling under repetition has been found in the two studies, both cases of 'learning' (in our sense) leading on to a final condensed, closely knit, and stable outcome. Modifications of this sort are responsible for the economy, promptness, and precision of output, which is the issue and not the process and procedure of actual learning.

The term 'task' attained an important place in psychology with Watt's work on *Aufgabe.* Its usefulness may still be increased. Elaboration of the task, its abbreviation, and its tendency toward extinction under reiteration have not received the consideration they deserve. That the task is sometimes set by occasion has been a

[7] See G. L. Freeman, The rôle of context in associative formation, this JOURNAL, 42, 1930, 173-212, (esp. 208-209), and pp. 215-216, above.

commonplace, but a general account of its functional genesis and sequel has awaited our study.

'Determination' in this study is not the same as the wholly neural hypothesis of Ach upon the 'determining tendency.' In developing the determining phase of acting out of the task, we have shown the place of functional aids supplied by searching, perceiving, inspecting, comprehending, imagining, and remembering. Our description of 'accessory factors' in acting seems to us an advance over the importance laid by Ach and other students of 'reaction' upon sense organ and sensation.

In rounding out the motor phase of acting we have been at pains to integrate muscular activity with those antecedent and succeeding functional moments which complete the phase of resolution.

Much remains to be done. The present investigation has improved our understanding of what goes on in one variety of simple acting. Complex actions, choices, resolves, and equivocal situations remain for study in this single mode of operation, and enough has been done in a preliminary way to suggest that in the other primary modes of psychological functioning, too, the same fundamental facts of progressive change may be found to underlie the perfected or 'learned' performance.

Conclusions

This study has described the functional course of certain instances of acting and it has tried to demonstrate how this sort of performance changes under repetition.

The successive phases of acting have been found to evolve from, and to be describable in terms of, a wide variety of interrelated functional moments. The task variously appears, determination develops out of many factors, and the whole leads on to motor resolution and accomplishment.

Functional modifications brought about by repetition have taken the two general directions of expansion and reduction. The final result has been described as a unified, stable, and highly integrated performance.

MATHEMATICAL OBJECTS AND SYMBOLIZING

By T. A. RYAN, Cornell University

In spite of the frequent use of the terms 'symbol,' 'symbolizing,' and 'symbolical' in discussions of the 'higher mental processes;' these words are rarely defined in any adequate psychological fashion. It is the purpose of the present study to consider the activities and products of activity of the human organism when engaged in mathematical pursuits, which are said, in common phrase, to be highly 'symbolical,' *i.e.* to operate with characters and expressions which 'stand-for' something which they themselves are not. This is a logical, not a psychological, use of these ambiguous terms. It is the psychological characterization, however, which we shall hope to clarify and to define in the present study.

As we shall presently see, to define or to describe an object as logically symbolical does not necessarily imply any fact which is psychologically significant. Logical 'standing-for' does not always carry with it a descriptive or psychological 'standing-for.' Take the instance of the dollar bill which I hand to the grocer. The bill is symbolical in the sense that it stands-for a certain amount of metal in the Treasury vaults. Descriptively, however, no such 'standing-for' is involved as I pay for my groceries. In common speech, I do not under these circumstances 'think about' gold or metal.

The above distinction is important because of a common tendency in psychological treatments of thinking and understanding to confuse logical with psychological symbolizing. The result of this confusion has been that the psychologist has concerned himself with many logical and epistemological problems which fall quite outside his own descriptive subject. Throughout this paper we shall use the unqualified term 'symbolizing' to denote a psychological process or activity in which a *descriptive* moment takes the place of the *logical* 'standing-for.'

Let us first characterize and limit in a provisional way the notion of 'standing-for.' We shall speak of symbolizing, in the psychological sense, only where there is a definite transition or shift from one object to another. For example, object *A* symbolizes object *B* if, having produced object *A*, the organism is then led to produce object *B*. This characterization is still too broad, however, for usage has imposed further limitations upon the use of our term. If *A* is a necktie perceived and *B* is a necktie remembered, no

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one would say that the first tie symbolizes the second. On the other hand, if *A* is a perceived or remembered necktie and *B* is a class or concept 'neckties-in-general,' 'dress,' or 'discomfort,' *A* would commonly be regarded as a symbol.

We are forced, then,—if we wish to describe psychological facts and, at the same time, to retain as much as we can of the common use of the terms with which we must deal—to give a clear account of the object which is 'symbol,' and the object which is 'symbolized.'

Classification of psychological products or objects. The term *object* will be used throughout this paper to designate any *product* or *issue* of psychological performance, whether a desk (regarded as a product of perceiving), a remembered incident, or a topic (which issues from comprehending).[1]

Since we intend to define symbolizing as a transition from one kind of object to another, we must give some consideration to the classes into which these objects or products may be sorted. We do not wish to make any assumptions concerning either the activities which turn out the objects involved in symbolizing or the activity which produces the characteristic transition. For this reason we must classify objects in terms of characteristics which are attributive to the objects themselves quite apart from their functional origins. To describe one object as apprehended and another as a comprehended product simply names the source of the product and does not describe the product itself. Like products may issue from unlike performances, and unlike products from the same kind of activity.

In the experiments which will be described presently the observers were asked to report in terms of products and objects rather than in terms of activity. From the descriptions obtained in this way a detailed classification of kinds of psychological issues was gradually worked out. Because of the large number of products involved, it is of course possible to classify from a number of points of view. In choosing his categories, therefore, the experimenter has a certain degree of freedom, since he must always emphasize certain characteristics of objects at the expense of others. The mode of classification which we have chosen is not, therefore, the only possible one.[2]

The scheme of classification which we have chosen has two advantages. First, almost all of the objects described by our observers fit easily into it.

[1] For a full discussion of the psychological relevance of regarding objects as products of activity see Madison Bentley, A psychology for psychologists, *Psychologies of 1930*, 1930, 95-114; *The New Field of Psychology*, 1934, Chap. I.

[2] Although the classification was progressively developed during the course of the experiments, none of the distinctions or terms involved were ever suggested to the *Os*.

Secondly, it is a scheme which is of especial significance for the problem of symbolizing. Because of lack of space we shall be able to consider only some of the more important headings and special subdivisions will be brought in only as we need them.

The three main headings under which we found it feasible to divide the products are as follows: (1) Spatial-temporal objects, (2) Intermediate objects, and (3) Objects without spatial-temporal qualifications.

The first group is most easily characterized. It is the 'phenomenal world' of colors, sounds, odors, solid objects, events, and the like. It includes almost exclusively products of apprehending (perceiving, remembering, and imagining), but it is, in its own right, a unique group without regard to functional origin.

In the second group we place objects which are only partially describable in spatial-temporal terms. For example, one kind of object which belongs to this class is the *generalized* spatial-temporal object. Such an object may have more or less definite shape, position, color, and so on, but in addition possesses another aspect, to be provisionally called 'generality,' which cannot be described in these terms. The product is *a* bird or a bird of this *general kind* rather than *this* apprehended bird. In this case, generality is an aspect of this single object and involves no symbolizing transition from one object to another.[3]

Objects of our third kind have always held a disputed position in psychology. The group includes topics, concepts, such directive objects as tasks and rules, and some of the 'thought elements' and 'meanings' of the Würzburg psychologists. Such 'meanings' were thrown out of psychology altogether by the structuralists, who regarded them as belonging to philosophy and logic. Others, while recognizing meanings as psychological, have attempted to simplify the problem by regarding them all as essentially the same, as 'thought-elements' or 'abstractions.' Regarding them as we do in their status as products of psychological activity, these objects have a proper and important place in psychology. We do not, however, try to oversimplify by regarding them as all-of-a-piece, or as constructed out of similar 'thought-elements.' Because of the great complexity of the comprehensive and elaborative activities of the organism, we may expect even greater complexity in their products, which comprise a large part of this third group.

In trying to order and command these non-spatial-temporal objects, we are hampered by a lack of descriptive terms. Most of our descriptive terms apply exclusively to the spatial-temporal kind of object. We shall therefore include some of the specific subdivisions of this class which were worked out in the manner already described. This rough subdivision will be useful in discussing our results and in making clear just what we include in this class.

Objects without Spatial-temporal Qualifications

(1) Directive objects
  (a) tasks
  (b) rules, laws, customs

[3] The unitary view of the generalized object is taken by Bentley in the *New Field*, 71-73. Descriptions of these objects are also to be found in W. S. Neff, Perceiving and symbolizing: an experimental study, this JOURNAL, 49, 1937, 376-418.

(2) Topical objects
  (a) Generalizing topics
    (classes and kinds as unitary products, *e.g.* 'vertebrate')
  (b) Bare indication
    (James' 'feeling of tendency,'[4] and the like)
  (c) Non-spatial-temporal characteristics
    (*e.g.*, 'loyalty,' 'anger,' and similar abstractions from spatial-temporal products)
  (d) Topical relationships
    (*e.g.*, sentences in which two or more topics are related while retaining a certain separate identity)

(3) Attitudes
  (doubt, assent, denial, acceptance, and the like, produced as separate from the objects which they modify[5])

With this grouping of the world of psychological issues or objects we shall be able to define symbolizing in a much more specific way. We have already said that we shall use the term to denote a transition from one object to another. We are now ready to state more specifically what the two terms of this transition are. The first term of the transition, the 'symbol,' is an object belonging to one of our first two classes of product (spatial-temporal and intermediate objects). The thing 'symbolized' is an object without spatial-temporal qualifications and belongs to the third class.

Our definition of symbolizing will thus include examples of the following sort: (1) I perceive a chair and pass from there to the topic of 'Colonial Furniture,' and (2) I proceed from the apprehended position of a statue to dwell upon the topic of 'courage.' There are, of course, many other ways in which the organism may pass from one product to another, and we shall have to consider these also. But these other kinds of transition will not be called *symbolical*. It is only by limiting the term in this fashion that it becomes useful and unambiguous.

Experimental procedure. The purpose of our experimental studies was to devise tasks and situations which call for 'mathematical activities,' and to obtain descriptions of the objects produced in the course of such performances. This general plan was limited in two important ways. First, it was imperative that we secure descriptions from psychologically trained observers, especially in initial studies of this sort. Those available were, however, only moderately advanced in their mathematical studies. Our materials were therefore limited to simple algebra, number theory, and geometry. Secondly, we have limited the pursuits under consideration to the 'understanding' of mathematical statements and arguments. We have thus left out of

[4] W. James, *Principles of Psychology*, 1, 1890, 249-255.
[5] Our *Os* report instances in which assent to a certain statement comes *after* 'understanding what it means.'

account for the present such other activities as the setting and solution of original problems, 'pencil and paper problems,' and the like.

Throughout these experiments, materials were so designed that they would call for rich activities, *i.e.* activities which were not highly habituated. In skilled performances the products are 'ready-made' and foreshortened, and, in consequence, extremely difficult to describe. By using novel topics and relationships, a greater degree of richness of report can be attained.

Preliminary trials, designed primarily for the training of *Os*, used sentences which were read aloud by *E. O* was seated comfortably in a dimly illuminated room and instructed as follows:

Listen to this [reading] and observe all the products of your activity. When you have finished the observation signal (by rapping on the chair-arm) and describe as fully as you can all products in the order in which they came.[6]

Materials. Fifty sentences were presented in the manner described. In order to bring out a wide variety of products the sentences included logical arguments and syllogisms, mathematical statements dealing with numbers and geometrical figures, and statements of 'general knowledge.'

Series 1. Grouped sentences and total equations were employed, each resembling a theorem or argument which might appear, for example, in a mathematical setting. The statements were typed on separate cards and presented ocularly, one at a time. The apparatus was a simple exposure-device operated manually. Formal instructions were as follows:

Here are three sentences given in order. There will be a certain relation between them. When you finish with each statement, signal and then report in terms of product.

Materials. In order to obtain the richness of activity and product which we desired, the groups of statements were so devised that the transition from one member to the next was not immediately apparent. Some active psychological manipulation was required before the comprehending of the relation or transition was carried through. Our results are therefore not comparable with earlier experiments dealing with the formal syllogism.[7] In the latter, a 'ready made' solution is available for most *Os*.

The series consisted of thirty-five groups of three sentences each. A number of the groups involved the same general topics, *i.e.* logarithms, prime numbers, and so on. The groups were so arranged, however, that during any one observation period each group belonged to a different general realm.

Because of limitations of space it will be impossible to reproduce a complete list of the experimental materials. We shall be content with one or two illustrations from each series. A typical group of statements from Series 1 is:

(a) The sum of all the angles of a triangle is 180°.
(b) The sum of all the angles of a parallelogram is 360°.
(c) The sum of the angles of a polygon of n sides is (n—2) 180°.

[6] Observers were M. L. Lemmon (*Le*), M. S. Ryan (*Sb*) R. M. Lindner (*Li*), and J. W. Macmillan (*Mc*), all candidates for the doctorate in psychology. Professor Bentley served as observer in establishing all series.

Our *Os* were familiar with the term 'product,' and all had had training in functional observation and report. Previous training had mainly stressed report of activity, however, rather than description of product.

[7] *E.g.* G. Störring, Experimentelle Untersuchung über einfache Schlussprozesse, *Arch. f. d. ges. Psychol.*, 11, 1908, 1-127.

The arguments were often, from a logical point of view, incomplete. That is to say, in order to give a rigid mathematical proof, *O* would have to draw from his general mathematical background. Many of the arguments were taken directly from theorems or 'originals' in mathematical texts. In such cases, unfamiliar theorems or unusual ways of developing the argument were selected.

To summarize, we wished to present a situation which would be as much like normal 'reading and understanding' of mathematical material as possible. Our situation was unique in so far as *O* could refer to previous parts of an argument only by memorial reinstatement, and had to stop after each sentence to report. Nevertheless, the method shows certain advantages over single words or sentences as used in traditional studies in thinking. Activity is directed toward a more restricted end-result and along a narrower course. As a first result we find less activity which is irrelevant to our central problem, and, as a second outcome, we are afforded an opportunity to study the transitions from one sentence to the next in a more or less connected and related series.

Series 2. Examination of the results of Series 1 brought out two kinds of object which were crucial to our treatment of symbolizing and which required more detailed description. One kind is involved in algebraical and numerical manipulation. The other consisted of objects produced by what *O* loosely called 'reading the sentence.' Series 2 was designed for close study of the first of these. It consisted of a series of 35 problems which involved substitution of values in equations, solution of equations, completion of numerical series, reduction of fractions to a common demoninator, and so on.[8]

Formal instructions were as follows:
Here is a problem. When you have solved it, signal and report in terms of product.

We reproduce one item of the series to illustrate the level of difficulty involved:
8. If $x = b$, and $y = n$ and $z = bx + 2xy + ny$, what is the square root of z in terms of *b* and *n*?

Series 3. Because *O* usually slurred over description of the products of 'reading the sentence' in the first series, merely taking them for granted, the present series was designed especially to study the objects which initiated performance. Sentences were presented to the eye as before in Series 1 and 2. Fifty sentences of varying type and length were used, including items of general knowledge, as well as specifically mathematical statements. The latter dealt with the same general topics as in the earlier series.

In order to obtain a variety of modes of 'symbolic reference,' some of the sentences began with connective words, some were algebraical rather than verbal, and a few were repetitions of sentences from earlier series. In addition, a number of abbreviations were inserted.

Formal instructions were:
Here is a sentence. As soon as you have read it *once,* signal and report in terms of product.

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[8] As in the other series, the problems were kept difficult enough to avoid ready-made answers. The set of problems drawn up originally served very well for 3 *Os.* They proved, however, to be too difficult for *Li,* and were not accepted by him as problems. We therefore made for *Li* an accessory set (Series 2B) of slightly simpler problems, keeping the same general type.

It was not expected that these instructions would be invariably effective. They did serve, however, to cut short the activities succeeding the actual reading, and to lay the principal stress on descriptions of the products of the reading itself.

Because of the varied nature of the sentences used in this series, it is impossible to select representative samples. As an illustration of the sentences involving connective words we may select the following:

36. Nevertheless we can always find an answer to this important problem.

Results of Series 1-3.[9] *Symbolizing.* Although words, sentences, numerical and algebraical characters and formulae are commonly supposed to be essentially 'symbolical,' symbolizing, in the sense in which we have defined the term, occurred only occasionally in these experiments. That is, *transitions* from one object to an object of quite a different order were the exception rather than the rule. In succeeding sections we shall describe the more common occurrences and kinds of object.

Nevertheless, in spite of their infrequency, examples of symbolizing were numerous enough to permit a separation into two main groups. The division is effected on the basis of the specific kinds of object involved in the transition.

(1) *Spatial-temporal object and generalizing topic.* The most frequent kind of symbolizing which we find in our results is that in which *O* passes from a particular spatial-temporal object to the 'class' or *generalizing topic* to which it belongs.[10] Almost as common are transitions from the topic to the spatial-temporal object as an *example* of the class. In the following excerpts from the reports we find illustrations of both kinds of transition:

Comp (sentence) > imag (man at RR station with plenty of money to buy his ticket)[11] (*Mc-3-32*)[12]

Comp (meaning and truth of statement) [After signal] imag (four-sided figure making two triangles and a triangle making one). (*Sh-3-26*) [The number of triangles which can be made from a polygon is two less than the number of sides of the polygon.]

Imag ($2^3 - 2^2 = 8 - 4$) > comp (with every number greater than two the discrepancy would be greater). (*Le-2-22*)

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[9] The preliminary series will not be discussed because its purpose was primarily to train the *O*s. Any results which might be derived from it come out in much clearer fashion from later series.

[10] This is called by Neff (*op. cit.*, 409-410) *topical reference.* He distinguishes this from symbolizing proper where the spatial-temporal object is "conventional and non-representative." This notion of symbolizing coincides more or less with our second group of symbolizings. Neff's views and results will be dealt with in more detail later (cf. p. 300).

[11] See p. 224, above for a list of the abbreviations which will be used in the reports. In this paper, brackets either indicate remarks made by *O* or enclose the problem presented.

[12] Identification of report (*O*, number of series, and number of particular item in the series). Where the report is clarified by a reference to the presented material, this will be given immediately after the number of the item (*e.g.* example two).

[Read equation] > com ("Oh, yes, when you multiply the powers are always added") (*Sb-1*-2B) [$a^e \cdot a^d = a^{e+d}$]

(2) *Symbolizing involving other topical objects and tasks.* We also find a kind of transition which is more 'conventional' or arbitrary than our first kind. We might even speak of it as more 'highly symbolic.' In the group of symbolizings discussed above the spatial-temporal term of the transition 'belongs' logically to the class or generalizing topic which forms the other term. In this sense it is representative. In this second group we do not find this relationship but we find that other topical objects such as topical relationships, 'abstracted' characteristics, and the like, or that directive objects such as tasks, take the place of the generalizing topic.

Per (dots) > sudden non-verbal comp (they mean multiplication, it is x times x times x). (*Mc-3*-12) [$x^3 = x \cdot x \cdot x$]

Imag (0 over some number made up of three digits) > com ("infinity") > fl (there is an infinite number of fractions between 0 and 1). (*Le-3*-29)

Translation, noting and comment. The organism may 'understand' written or spoken language without producing any 'concepts,' tasks, or other non-spatial-temporal objects. In fact, 'understanding' may involve no more than *translation* of the pattern of letters directly into an imagined or remembered spatial-temporal object. In addition, verbal characters (notably subvocal motor patterns) may serve the organism as aids or resources in emphasizing details or characteristics of apprehended objects, in inspecting or examining. This latter use of verbal characters we shall refer to as *noting* or *comment.*

We might have included such translation and comment in the definition of symbolizing. For the sake of clarity, however, it is better to keep them separate. The separation emphasizes in the first place the fact that 'understanding' does not necessarily involve topical objects. In the second place, if we were to include translation and noting in the definition of symbolizing, the definition would become so broad that it would include any instance in which a spatial-temporal object leads to the recall or imagining of another. The only difference between translation and any instance in which one apprehended object leads to production of another apprehended object is that the former happens to involve verbal characters.

In the following instances of translation it is obvious that no non-spatial-temporal products were involved. In many cases direct questioning substantiated this conclusion even though some of the *O*s were troubled by preconceptions that there *must* be some 'meaning' or conceptual object involved in language.

[Significance of sentence carried by] imag (figure with a line drawn from top to base, just any figure, not especially a parallelogram). (*Sb-1*-3B)

[Accompanying reading of sentence] imag (two short lines opening out to make a wider angle). (*Le-1*-25B)

[At word *diameter*] > comp [by way of] imag (circle with a line through it). (*Sb-3*-23)

Vocal translation. A sentence is often translated into a vocal motor pattern from the visual pattern. This subvocal or vocal pattern may in turn 'carry meaning.' The nature of such translation will become clear in a later connection.

Noting and comment. The use of vocal patterns as aids in inspecting has already been described by Hunt.[13] We need present only one illustration here out of the large number which occurred in our reports:

Com ("No, the angle at one end of the diameter is larger than the one at the other end"). (*Sb-1*-26C)

It is to be emphasized that our *O*s used the term *comment* in a much broader connotation than that in which we use it here. Therefore the label "com" in our protocols is not necessarily significant and we have to take into consideration the whole report. Often *O*'s report of *comment* referred to topical objects which came in verbal form.

Linguistic objects. It has long been assumed in our tradition that one or more of the transitions from object to object discussed above (symbolizing, translation, comment) exhaust the possibilities of the organism as it deals with verbal signs and characters. One of the most striking results of our investigation has been, however, that the organism may deal with topical objects and with verbal characters *without symbolizing* in the strictly limited sense which we have adopted. Instead of symbolizing, the organism deals with *linguistic objects.*

By the term *linguistic object* we shall refer to a close integration of a spatial-temporal pattern with an object of another order. The spatial-temporal pattern is not, as in the case of symbolizing, an initiating and governing factor which leads to the production of other, separate objects. Instead, both the pattern of letters and the topical or directive object are turned out as a single, integrated unit. Both are there-at-once; there is no transition from one to the other. Our results indicate that by far the greatest portion of our reading is done in terms of such integrated products.

Most of our illustrations will be drawn from Series 3, which was designed especially for study of the objects involved in 'reading the sentence.' On the basis of the descriptions obtained in this series we have divided the linguistic objects into four separate groups: (a) unintegrated, separate word-objects, (b) unitary sentence-objects, (c) progressively developing sentence-objects, and (d) 'ready-made' sentence-objects.

(a) Unintegrated, separate word-objects. Separate word-objects may appear in instances in which a sentence-object also appears. These will be considered under (b)

[13] J. M. Hunt, A functional study of observation, this JOURNAL, 47, 1935, 1-39.

and (c). Here we are most interested in those instances in which no sentence-object appears. *O* turns out a number of separate objects which form no unitary whole:

[After signal] > rem (words 'rate of speed' and that my physics teacher protested against the phrase) > rem (*acceleration*) > comp (topic which deals with falling bodies which increase speed as they fall) > rem (*differentiation*) > comp (they don't seem to fit together). (*Le-3*-14)

(b) Unitary sentence-objects. The sentence as a whole may appear as a unitary object preceded or not by separate word-objects. The following illustrations demonstrate both possibilities.

Per (words) > comp (sentence as a whole) [Simply understood it, no specific reference to its truth or falsity. Comp came immediately]. (*Le*-3-9)

Per (words 'economic status') > comp (they mean something about money) > per (*cultural level*) > imag (quick succession of pictures of primitive people and of modern civilization) > com ("maybe it is true and maybe it isn't") [Sentence just suddenly there all at once]. (*Mc-3*-13)

We shall not stress the question whether preceding word-objects are necessary to the development of a sentence-object. They do appear very often in our reports, but such word-objects may be an artifact of the task to report. Questioning sometimes brought out the fact that a unitary sentence-object had been broken up into word-objects for ease in report.

(c) Progressive development of a sentence-object. Here the sentence-object is gradually built up as the reading of the words progresses. The course of events is analogous to that of melodic progression, in which separate notes have an individuality of their own and at the same time are progressively integrated into the total melodic object. In the following illustrations it is evident that grasping a particular word or phrase involves a progressive change in the products of previous portions of the total performance:

[Subvocal reading] (*the articles are to be found*) *cum* comp (articles such as lamps, etc.) > imag (some room and the names of the articles in it) > [read the second line] > per (*Arch. f. d. ges. Psychol.*) > comp (*articles* became written articles belonging in that journal). (*Sh-3*-49)—These articles are to be found in the *Arch. f. d. ges. Psychol.*

[At the words *the trial*] > com ("what trial?") > [at *in Moscow*] > com ("oh, yes"). (*Li*-3-9)

(d) 'Ready-made' sentence-objects. All of the linguistic objects depend heavily upon conditions in the individual's past. Some of the sentence-objects show a greater degree of such dependence than do others. In those which we shall call 'ready-made,' the whole sentence is already prepared and is so foreshortened that it is merely 'that familiar sentence.' Often it is accompanied by a specific memorial reference to occasions on which *O* has dealt with the same topic or sentence in the past.

[Read it subvocally, no perc of words after first one or two; just familiar, a thing always given as the truth]. (*Sh*-3-48)

Per (sentence as a whole). [no reading from word to word] > com ("yes") > [Signal] > rem (having learned that last spring). (*Le*-3-42) [The *Amer. J. Psychol.* was founded by G. Stanley Hall.]

In most such 'ready-made' objects the comprehended product includes an explicit aspect of factuality or falsehood. In other kinds of sentence-object acceptance or denial comes more often, if at all, *after* the 'understanding.' Assent and other such 'attitudes' come as separate products. In the 'ready-made' sentences, on the other hand, assent and the like are characteristics of the product itself.

Non-literal linguistic objects. Our previous illustrations of linguistic objects have all been topical products in which the spatial-temporal pattern was a formal or conventional character. Nevertheless, we also find that this pattern may be of any kind whatever, and our previous definition is broad enough to include any spatial-temporal pattern. The object is of essentially the same sort whatever the spatial-temporal side may be. We shall sometimes speak, however, of *non-literal* linguistic objects simply to emphasize that linguistic objects are not coextensive with formal language.

In our experiments it is sometimes difficult to distinguish such non-literal linguistic objects from *translation. O* does not always distinguish in his reports between the course of events in which he passes from the formal characters to a *topical* object in which is integrated some spatial-temporal pattern, and the course of events in *translation* proper where no topical objects are involved, and where the 'meaning' of the words is simply another spatial-temporal object. As a result, we have many doubtful cases, but we have in addition a number of clear-cut cases from which we have already cited instances of translation. The following constitute well-marked reports of non-literal linguistic objects:

Comp (*cyclic character*) [carried by] imag (circle with a quadrant in it).[14] (*Le-3-30*)

Rem (card table at home) [this meant that the sentence referred to bridge]. (*Sh-3-38*)

Mathematically characterized spatial-temporal objects. We have not yet exhausted the ways in which the organism may deal with conventional signs and characters. In solving algebraical and numerical problems the organism produces, under certain circumstances, still another kind of object which we call, for lack of a shorter term, the *mathematically characterized* spatial-temporal object.

Like the generalized object mentioned in our introduction, the mathematically characterized object is a pattern which has certain properties not describable in spatial-temporal terms. These properties are not, however, identical with the 'generality' aspect of the generalized object. We can explain what these properties are only by reference to examples. The character *25,* which has a certain shape, size, and position, *is* in addition a squared number, divisible by 5, or may have other properties determined by the context at the moment. Yet it is the character on the page, the spatial pattern, which possesses these properties.

Such mathematically characterized objects must not be confused with linguistic objects. In the latter, spatial-temporal pattern is less prominent. The total object is essentially a *topic* or *task* and the pattern of literal char-

[14] There is also the possibility that literal character, other spatial-temporal pattern, and topical object may *all three* be integrated into a single unit. It is sometimes difficult to determine from the reports whether or not this has occurred. If it does, however, we are still dealing with a linguistic object.

acters (or other spatial-temporal pattern) is more or less incidental, while in the mathematically characterized product, spatial and temporal pattern are relatively more important. We therefore regard these products as forming a group intermediate between the two extreme classes of products and as coordinate with generalized objects.

Before presenting our evidence, an analogy from another setting may make clear our position. 'Being angry' is not a spatially or temporally describable property of an individual. Yet it is a spatially defined person who *is angry*. The 'squaredness' of the character *25* has become for the adult organism a property of the spatial pattern in the same fashion that 'being angry' is a property of some human organism. Because of this analogy we might use the term 'physiognomic' to describe such extra-spatial characteristics.

The properties attributive to these mathematically characterized objects fall into three main groups: (1) 'static' or permanent properties; (2) 'dynamic' properties, and (3) relation-to-a-task. There is of course a great deal of overlapping, almost all of these products involving some relation to a task. The third group includes, therefore, only specially marked instances.

(1) 'Static' properties.

[Simply per each number and, as I do, per that it is a square. No trying of different numbers or anything]. (*Sb*-2-19)

Immediate per (relationship as 1, 2, 2 times 3, 4 times 6, and so on). (*Li*-2-16)

(2) 'Dynamic' properties. Here the organism anticipates the result of a mathematical manipulation to be carried out upon the object. The result of such an anticipated manipulation is included in the properties of the object *without* any operations actually being carried through.

Per (left side of the equation as having the potentiality of being expanded into three terms). [Nothing formulated, just a familiar form which would expand in this way]. (*Le*-2-31)

Imag (36/12) > per (that was equal to 3). [No division, just bare comp or app of some sort. Nothing verbal and no imag]. (*Sb*-2-17)

(3) Relation-to-a-task. Instances of a 'negative' relation-to-a-task are more frequent than a positive relation; possibly because an instance of the latter sort would fall in one of the first two groups. The negative relation-to-a-task is usually one of 'confusion.' The object lacks some property necessary to the solution of the problem, and therefore appears confused:

Insp (two fives together and a 1 later in the series) > fl (this is a difficult problem). (*Sb*-2-35)

Per (top member). [dismissed it as too confused]. (*Le*-2-32)

Most of our evidence concerning the nature of these objects is indirect; the properties which we have discussed are implied rather than explicitly described in the reports. When we attempted through questioning to secure

more explicit descriptions, we were limited in our success by certain assumptions on the part of *O* which we shall discuss presently. Even there, however, we find the implication that it is the black-and-white pattern on the card before *O* which *is* a series of squares, divisable by 2, the square of $(x-y)$. Even the manipulations of addition or other operations do not stand-for addition; these spatial-temporal events *are* addition.

We present the following replies by *O* to *E*'s questioning to illustrate the difficulties presented by certain general logical presuppositions. They also show that the points which we have made show through in spite of these difficulties. (Q) indicates *E*'s question: *O*'s reply is given in brackets:

(Q) Were they per as squares?[15] [I think so but I am not sure of the difference between per and comp in these cases]. (Q) Was 'square' a characteristic of the objects on the card? [Yes, I think so]. (*Sb-2*-23)

(Q) Was the connection a property of the perceived objects? [It was inherent in the series.—It does seem to be there before me, but I don't think it comes as per. There is a 'there' quality or a belonging quality about it]. (*Li-2*-27)

(Q) Would you call this per? [I don't believe so, it was immediate, but that doesn't determine]. (Q) Were these things characteristics of the objects on the card? [They go beyond what is there. That is why I call it comp. If it were mere perceptive product, it would simply be apprehended as a number between 35 and 40. Here there is a task to look-for-a-multiplier]. (*Le-2*-21)

The first two of these illustrations simply indicate hesitance in giving a definite answer, although they tend to support our position. The third indicates a possible reason for this hesitance. It is obviously in logical rather than in descriptive terms. Even so, *O* grants that the property of 'being between 35 and 40' may be a direct property of the objects before him. The assumption with which we must contend and which prevents definite replies to our questions is apparently that whenever two functional resources are employed, two separate products *must* result. It is an assumption which, as we shall see, runs throughout the earlier history of investigation of 'higher mental processes.'

If we return to the first illustrations of mathematically characterized objects, we shall see that, where *O* had no occasion to reflect and call upon logical background —where he *describes*, rather than *discusses*—the situation is much more clear. Our characterizations are there amply supported.

Automatized manipulation. In addition to the mathematically characterized objects, there was, especially in Series 2, a large amount of highly habituated activity which runs its course very swiftly. Individual objects turned out by such performance are often extremely fleeting, and their main characteristic is that they direct performance onward. In such automatized activities, individual products do not possess mathematical characteristics; they are simply spatial-temporal patterns which direct per-

[15] As we have previously stated, our primary interest in this study lay in the direction of product rather than in modes of performance. Because of a lack of established terminology for the products dealt with here we thought it well to question *O* concerning function in the hope that the reply would bring out more information on product.

formance along the way in much the same way as the perceived sidewalk directs one walking on the street. The following illustration presents a series of such patterns (in this case, vocal-motor):

Com ("3 times 3 is 9, 3 times 9 is 27"). [Trying it out to see if it worked with the numbers presented] > Com ("3 times 81") > imag (the multiplication) > [Read off from that] ("243"). (*Sh-2-25*) [What is the next term of the series 1, 3, 9, 27, 81?]

Here the solution had already appeared. Getting the 'right answer' was simply a matter of automatized manipulation once the pattern of the series was clear.

Tasks and symbolizing. The discussion has until now been confined to one group of the non-spatial-temporal products, the topical group. We must now consider the relation of tasks to other objects.

As a product of human activity a task is always of a different order from other products. Therefore, following our strict definition of symbolizing, any situation which leads to the production of a task would be symbolical, and our term symbolizing is again in danger of becoming too broad to be useful. We must therefore limit the term still further. In doing so, we take into account not only the fact that a task is involved, but also the direction in which the task leads.

Suppose I am engaged in solving a jig-saw puzzle. I see a particular piece, and the task is produced 'put this piece in the upper-left corner.' This would scarcely be called symbolical. On the other hand, the perception of a red light followed by the task 'stop the car' may be considered symbolical. The difference lies in the fact that in one case the resolution of the task lies within the same situation in which the task arose. In the other (red light) stopping the car has nothing to do with the properties of the red light.

When a spatial-temporal object leads to the production of a task, we shall, then, regard this transition as symbolical only when the resolution pointed-towards by the task lies outside the realm of the original spatial-temporal situation. It now becomes apparent that the sequence: number object > task = 'multiply by 2,' is not symbolizing. The resolution of the task lies within the realm of number-objects in the same fashion that placing the piece of a jig-saw puzzle lies in the same realm as the apprehended piece. Most of the transitions from-a-product-to-a-task which occur in our experiments are of this same non-symbolical sort. Only in a few instances do we find symbolizing with respect to tasks, and in these instances the shift to the task is often accompanied by a shift to another topical realm at the same time.

Tasks as linguistic objects. The task, like the topical object, may be

closely integrated with verbal characters or other spatial-temporal patterns as a *linguistic* object. In the following illustrations the verbal character is subvocal-motor:

[Read it] > com ("I never can do that") > non-verbal SI (try it anyway). (*Sb-1*-6C)

Com ("Well it is not so hard, try it with this"). (*Le-1*-4B)

In the first of these excerpts we have included two tasks, one as a linguistic object and the second in non-linguistic form. The second is included for the sake of those who are misled by the frequent linguistic form of the task and, as a result, would regard the task as no more than the vocal characters. We might illustrate at great length from our results the fact that tasks may appear either with or without integration with verbal characters.

We must emphasize that responding to (say) a traffic signal does not necessarily require symbolizing or linguistic objects. In fact, it may not even involve a task. We make this point here in order to set off our point of view from others which will be discussed in the succeeding section. In our hypothetical case of symbolizing with the red traffic signal, we explicitly stated the order of events: perceived red light *followed by* the task to stop. For the practiced motorist we may suspect that the red light has become integrated into a linguistic or other object, the red light is itself a part of the task-object. There is still, however, a third possibility. The stimulus, striking the retina, leads automatically to the motor performance of stopping without any task and even without any perception of the red light. In this case we have neither symbolizing nor linguistic object. In other words, in defining symbolizing and linguistic objects we have nothing to say concerning stimuli; our whole discussion has been in terms of products of activity. This will become important when we come to discuss other views of symbolizing, particularly the behavioristic view.

Other views of symbolizing and language. The definition of a symbol as anything which stands for something else has been construed in a variety of ways. Some have taken the statement as it stands, with the result that even perceiving is labeled 'symbolical' since the perceived object 'stands-for' the stimulus, 'physical reality,' or what not.[16] This notion need not seriously concern us since it is essentially an attempt to solve the philosophical problem of the relation of psychological products to a 'real world,' a problem which is not our concern.

Others have left the definition in just as broad terms but have, in practice, restricted the term symbol to more or less formal means of communication, language, signal signs, and the like. It is these notions of symbol upon which we must comment.

The behaviorist, discarding as he does any reference to psychological products, speaks of *symbolical response* or *behavior*. Just how symbolical

[16] *E.g.* see A. N. Whitehead, *Symbolism, its Meaning and Effect*, 1928, 1-198.

responses can be differentiated from any other response without reference to psychological activities and products it is difficult to understand. The behaviorist is usually reduced to some sort of genetic definition in which the symbolical response is one which depends upon past 'generalization' of the stimulus situation.[17] He is able to offer no *descriptive* terms which characterize the symbolical response at the time of responding: his definition is entirely in terms of historical conditions. It is as though we tried to *describe* the esthetic qualities of a painting in terms of wave-lengths of light.

Other historical points of view have been less superficial. The primary difference between these other views and our own is that most of them make the psychological almost coextensive with the logical definition of symbolizing, trying to make all logical symbolizing fit into a single psychological pattern.

The structural position, by limiting the concern of the psychologist to spatial and temporal pattern (indeed to the sensational part of the pattern), takes the question of topical objects, language and symbolizing entirely outside the realm of psychological investigation. Studies of language and understanding were, it is true, undertaken from the structural point of view but always under the assumption that the psychologist's only concern is with the 'conscious correlates' of meaning, never with meaning itself.[18] It is becoming apparent, however, that it is necessary for the psychologist to describe the whole realm of products of activity, including 'meaning' or whatever we may call the non-spatial-temporal objects. Until the psychologist has adequate descriptions in his own terms he cannot progress very far in his investigations of the 'higher mental processes.' Structural investigations have been useful in one respect. Their results furnish valuable indications of possible apprehensive resources or moments in comprehending. In scrutinizing these results we must, however, keep before us the point of view under which they were obtained.

In the Würzburg group we do find symbolizing considered as a psychological problem. Here is effected a universal separation of spatial pattern from the objects variously called 'meanings,' *'Bewusstheiten,' 'Gedanken,'*

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[17] In K. L. Smoke, An objective study of concept formation, *Psychol. Monog.*, 42, 1932, (no. 191), 1-46, concept formation is defined in terms of a 'symbolic response' to the members of a *class* of stimuli. The assumption is, apparently, that stimuli form *themselves* into such classes as triangles, circles, and the like.

[18] *E.g.* T. Okabe, An experimental study of belief, this JOURNAL, 21, 1910, 563-596; E. Jacobson, On meaning and understanding, *ibid.*, 22, 1911, 553-577; E. B. Titchener, Description versus statement of meaning, *ibid.*, 23, 1912, 165-182; and J. M. Gleason, An experimental study of 'feelings of relation,' *ibid.*, 30, 1919, 1-26.

and the like.[19] Any word is made to involve two separate objects, spatial-temporal pattern and 'meaning.' According to this view, all language would fall under our rubric of symbolizing.

This notion is based, however, upon certain epistemological or upon *a priori* genetical theories rather than upon descriptive considerations. 'Getting the meaning' is supposed to require a special '*Akt*' beyond the act of apprehension. Therefore there must be two separate objects. Thus the main point of difference between our descriptive account and that of the Würzburg group hinges upon the linguistic object, which we have described as a single, unitary object and which the Würzburg group would describe as dual.

If we leave general trends and 'schools' and look to more specific treatments of symbol and language, we find several investigators who approach from various directions our notion of linguistic object.

James describes an object which is very close to our linguistic object.[20] It is true that he tends to emphasize hypothetical explanations in terms of 'fringe' and faint brain processes of an associated sort. In his illustrations, however, he seems to regard verbal character and fringe as a single whole. He separates out artificially three kinds of fringe, which, together, make up the 'sense' of a sentence. The descriptions of our *Os* would suggest that his analysis is both artificial and oversimplified.

Koffka presents ten 'levels of understanding' for single words in the word-association method.[21] Many of these levels are useful only for the special method from which they come. Others are not levels of 'understanding' at all, but simply ways of apprehending the spatial-temporal pattern of characters. Some of the levels, however, correspond very closely to the four types of interrelation we have described as symbolizing, linguistic object, translation, and comment. Koffka does not come to specific terms with the question of duality of object in language but he does not emphasize the separation as sharply as earlier 'Würzburg' investigators had done.

Stern, although he follows the tradition of a sharp separation of 'thought-objects' (*Gedanken*) from apprehended objects (ideas), gives some indication of a reciprocal relation between them.[22] He distinguishes the *Zeichen* or arbitrary sign from the *Symbol. Das Zeichen* is an apprehended object which 'stands-for' some *Gedanke*

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[19] These and other terms overlap in various complicated ways which need not concern us here. *Bewusstheit* is Ach's term, while *Gedanke* belongs primarily to Bühler (as a specialized term). Cf. N. Ach, *Über die Willenstätigkeit und das Denken*, 1907, and K. Bühler, *Tatsachen und Probleme zu einer Psychologie der Denkvorgänge*, 1. *Über Gedanken., Arch. f. d. ges. Psychol.*, 9, 1907, 297-365. All of these terms are too broad to be translated into our schema of objects. Titchener's *meaning* included even spatial-temporal objects beyond sensation and image; Ach's *Bewusstheit* included even 'familiarity' as an aspect of an apprehended pattern.

[20] W. James, *op. cit.*, I, Chap. IX. (esp. 264).

[21] K. Koffka, *Zur Analyse der Vorstellungen und ihrer Gesetze*, 1912, 368-372.

[22] W. Stern, *Allgemeine Psychologie auf personalistischer Grundlage*, 1935, 375-383.

but which is so highly schematized that it has no significance in its own right as an apprehended object. Mathematical, chemical, and other scientific shorthands belong to this category. The symbol, on the other hand, is an apprehended object which has the representative role of the *Zeichen* and, in addition, has in its own right a certain meaningful character. Stern cites the cross of Christianity as an illustration of such a symbol. This, he says, has not only an indicatory character but somehow belongs implicitly to the topic of Christianity. Natural language, since it grows up along with thinking, also possesses this characteristic of the symbol.

Stern has a genetic theory which accounts for these two kinds of representative objects. We need note here, however, only the fact that the symbol bears some resemblance to our notion of linguistic object. The representative or 'standing-for' character of both *Zeichen* and *Symbol* is still, however, entangled with logical concerns. The 'function' of the *Zeichen,* Stern says, is to 'represent' thoughts. How it represents and just what the relations between apprehended object and 'thought' are, Stern does not tell us.

Neff's study, already mentioned (footnote 10), deals with extensions of the apprehensive functions in the direction of comprehending. Since he makes no attempt to consider formal language, his results will naturally differ from ours. His notion of 'topical reference' coincides with one of our classes of symbolizing, the sort which involves a spatial-temporal object and the generalizing topic to which it belongs. 'Symbolical reference' also involves a spatial-temporal object and a topic, but Neff's notion of symbol is quite different from our own. ". . . a fundamental property of the symbol is its conventional and non-representative character."[23] Again, "the object is now apprehended as bearing a significance beyond what it actually depicts."[24] The first of these requirements limits the scope of symbolical 'reference' to our second kind of symbolizing but it may also include translation and comment where the verbal characters are certainly 'conventional.' The second requirement hinges upon the term 'significance,' which is, as Neff implies, a topical object of some kind. 'Topical' and 'symbolical reference' correspond, then, roughly with the two classes of symbolizing which we have made out.

There are, however, certain difficulties with Neff's treatment which are eliminated by our own method of looking at symbolizing. First, the term 'conventional' which Neff emphasizes is somewhat ambiguous. In another portion of the study he speaks of 'conventional*ized* drawings,' which are not symbolical but depictive or representative. Yet, in connection with symbolizing, the term 'conventional' refers to objects which are non-representative. If we regard both the topical and symbolical kinds of reference as symbolical, we eliminate the need of differentiating sharply between them, and consequently the need for this troublesome term. It may be that the distinction between the two is more logical than psychological.

Secondly, the word 'reference' is itself troublesome. Neff uses it in a straightforward fashion, it is true. An object has *memorial* reference if it leads the organism to remember; *topical* if the organism passes from the spatial-temporal object to a topic. Others, however, use the term in a half-mystical sense without any account of what the organism does. Neff's use of the term may consequently be misinterpreted.

[23] Neff, *op. cit.,* 410.
[24] *Ibid.*

By restricting our consideration to symbolizing alone or to linguistic objects alone we find certain points of contact between our own and other psychological treatments of 'signs and symbols.' If we survey the whole range of special kinds of objects and interrelations between objects considered in this study—symbolizing, linguistic objects, both literal and non-literal, translation, comment, mathematical objects—we see that our treatment allows for greater variety in activity and product than any of the others. The previous tendency has been to throw all reading and 'understanding' into a single pattern. Those who deal in 'thought-elements' tend to describe all reading in terms of symbolizing. Those who attempt to deal with reading in terms of traditional association tend to emphasize only the fact that words may be translated directly into other spatial-temporal objects ('images'), and to ignore topical objects altogether. Very often, such wide differences in position are traceable to epistemological theories which govern the investigator's whole outlook upon psychological questions. Whatever the reason, no one has taken account of this wide variety of products involved in what is loosely called 'understanding.'

Mathematical objects. As we might expect from the dearth of descriptive material dealing with language in general, we can find very little of a specifically descriptive sort dealing with the mathematical pursuits of the organism. In theoretical discussions, algebraical and numerical objects are simply assumed to fall into the same pattern as language and to be 'symbolical' in the same way. Where mathematical problems or materials have been used in psychological experiments, we find that the aims of the experiments do not include any description of these objects or of the kind of 'symbolizing' involved. Studies which make use of numbers or number-names may be grouped into the following classes according to the aim of each: (1) Range of perceiving experiments, and the 'estimation' of number; (2) Experiments on skill in arithmetical operations with emphasis on pedagogical principles to be derived; (3) Analyses, in arithmetical terms, of methods in simple calculation and studies of factors in ease and accuracy; (4) Arithmetical materials incident to the study of such general problems as 'Aufgabe' and determining tendency; and (5) A few descriptive studies concerned primarily with very simple operations.[25]

[25] One example of each class of inquiry will suffice: (1) H. Nichols, *Our Notions of Number and Space*, Boston, 1894, 1-201; (2) E. L. Thorndike, Practice in the case of addition, this JOURNAL, 16, 1905, 327-336; (3) C. E. Browne, The psychology of the simple arithmetical processes, *ibid.*, 17, 1906, 1-37; (4) N. Ach, *op. cit*, 197 ff; (5) B. Schanoff, *Die Vorgänge des Rechnens*, 1911, 1-120, in *Päd. Monog.*, (Meumann), vol. 11.

We do not minimize these experiments. They are valuable in the light of their aims, but they cannot be accepted as substitutes for description of the sort we have undertaken. Since the nature of symbols and symbolizing is taken for granted in these studies our most important questions are simply ignored.

Conclusions

We have defined *symbolizing* quite specifically as a transition in which the organism is governed by one object or product of activity in producing another object of a certain different order. Couched entirely in psychological terms, the definition is without logical or epistemological implication.

Symbolizing is only one means of 'understanding' language or mathematics. Besides symbolizing—which was relatively rare in our experiments—the following other means have appeared:

Translation (direct transition from word-character to another spatial-temporal or generalized object)

Comment or noting (words used as aids in picking out and emphasizing details of spatial-temporal objects)

Linguistic objects (topical or task object in which are incorporated letters or other spatial-temporal *characters* to form a single, unitary object)

Mathematically characterized objects (spatial-temporal characters, especially algebraical and numerical, to which accrue certain non-spatial-temporal properties, such as 'squared,' 'even,' 'divisible by 5,' and the like)

There were, to be sure, borderline forms; but the differences between objects falling squarely under our five classes were marked enough to justify the description as both significant and useful.

The spatial-temporal object involved in symbolizing, the literal characters in translation and comment, and the spatial-temporal aspect (or partial product) involved in linguistic objects, and mathematically characterized objects, have all, in the past, been loosely called 'symbols.' We have shown that, while they all may have the same status in *logical* account, in psychological description they serve in quite different ways. Through symbolizing and in linguistic objects the organism produces topics; in the one the spatial-temporal pattern is a part of a product, in the other it is an independent product.

Beyond emphasizing the importance of eliminating logical terms from psychological description, our research holds implications for the psychological activities themselves. Although we have been primarily occupied with a description of products of human performance, these products always imply psychological activities behind them. Linguistic and mathematically characterized objects are especially significant in passing from product to

process, for they give evidence of various functional resources combining in intimate coöperation toward productive ends.

Bentley has distinguished two primary functional moments or aspects, *pattern* and *determination*.[26] Since we have chiefly considered single and isolated part-performances turning out a single product, the 'determined' aspect has been almost negligible. The 'patterned' aspect accounts—of course—for the spatial-temporal side of our linguistic and mathematical objects. But the non-spatial-temporal qualification is still not accounted for. We might suggest, therefore, a further 'comprehensive' moment or aspect, obviously not universal (as pattern and determination have been held to be) but clearly implied in the present context. These three functional moments variously underlie our 'objects.' In the spatial-temporal varieties, *pattern* is the dominant aspect of function. In such non-spatial-temporal objects as non-linguistic topic or task, the *comprehensive* moment is dominant. Both moments are involved to varying extent in linguistic objects and mathematically characterized products, with pattern more prominent in the latter.

[26] Bentley, *New Field*, 321-330, 410-412.

A PSYCHOLOGICAL CONSIDERATION OF ANALOGY

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Analogy is a term familiar to the student of logic, to the poet, the mathematician, the artist, and the philologist. It has had many and varied uses: to discover relations through inference, to vivify poetic imagery, to elucidate prose, to indicate quantitative proportions, to test 'intelligence,' to clarify explanations, and to suggest underlying similarity among many objects, classes and kinds.

Regarded in its varied contexts analogy suggests to the psychologist such questions as the following. How does the organism manage to note analogical similarities? What resources does analogy call upon when it passes from a relation in one context to a similar relation in another? How does the reader of poetry, finding two things related in the text, grasp the implication that two other things, wholly different from the first and not actually mentioned, are similarly related? What happens when the allegorical painting or the cartoon is 'understood?' Reducing the analogical relation to literal symbols we may phrase the question, How does one pass from a given relation $a : b$ to the like relation $c : d$? Since a and b do not respectively equal, stand for, or symbolize c and d, we should like to discover how the one relation informs us upon the other, *i.e.* how two-terms-in-a-relation calls forth, or is to be identified with, two-different-terms-in-the-same-relation? It is obvious that all these psychological inquiries bear upon operations and activities of the analogizing organism. The very nature of the problem—as well as the whole history of analogy—readily convinces us that both description and explanation lie in the region of understanding and thinking, and it has been our hope that a fundamental research here might throw light upon these complex, 'higher,' and little-known activities of man.

The term 'analogy' has long been used to indicate a numerical equality between two members of an expression. Such an equation is commonly written by the arithmetician in the form 3:4 :: 9:12 or $3/4 = 9/12$. Its extension to qualitative relations is commonly credited to Aristotle. A simple qualitative instance would be black : white :: night : day.[1] In both quantitative and qualitative forms some aspect of 'equality' is indicated between the two members, each member itself expressing a

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[1] *Cf.* Article *Analogy* by A. Wolf in *Ency. Brit.*, (14th ed.), Vol. 1, 864.

relation.[2] Thus if *a* and *b* stand in a given relation (*x*), and *c* and *d* stand to each other in the same relation, than *a* : *b* is said to be analogous to *c* : *d*. It is not necessary to assume a one-to-one relation between the individual terms of one member and corresponding terms of the other.[3]

To be sure, a relation obtaining between two simple terms (*a* : *b*) only (as in the simile and the metaphor) is sometimes called 'analogy' by literary critics and writers, but we shall not include it in our study. Our interest, as we have stated, is in the problem as to how we grasp the relation implied in the expression *a* : *b* in such a way as to realize a like relation *c* : *d*. We hear, for example, the statement "every cloud has a silver lining" and derive the significance that nothing is wholly bad or that an apparent reverse will have a good or an agreeable outcome. This may be reduced to our simple scheme as *a* (cloud) : *b* (silver lining) :: *c* (an unpleasant experience) : *d* (a bright or pleasant aspect of that experience). We do not wish to imply that such an analysis *must* occur in the understanding of the proverb, but only to demonstrate that there must be a similarity of relation expressed in the literal statement to the relation present in the figurative implication.

The ability to relate things analogically has long been considered both desirable and difficult. Many writers of the last century urged the importance of the analogy in attaining new knowledge. The work of the creative genius is not mere observation—so they contend—but rather the ordering of the products of observation in analogical form.[4] Analogy they conceive to be a creative means to knowledge. To the logician the method of 'reasoning by analogy' has been "an argument from examples or instances," to determine the nature of an unknown object or process.[5]

A common example cites the astronomer who tried to account for a slight deviation in the course of a planet. Arguing from the known fact that planetary courses are due in part to gravitational influences from other bodies in their vicinity, he postulated

[2] We use 'member' to denote one side of the equation (*a*:*b*), 'term' to denote an element within the member (*a* or *b*).

[3] To illustrate in terms of concrete objects we may say that paper is to papyrus as shoe is to sandal, (*i.e.* a later and an earlier product used for a given purpose). Here the one member contains two objects of similar function and the other likewise two objects of similar function. There is no relation set between the objects of one member with those of the other nor between the functions indicated in each member; one does not associate paper with shoe or sandal, nor shoe with paper or papyrus, nor does one note a similarity between the functions of use-in-writing and covering-feet. Called upon to find something analogous to paper-and-papyrus, one could name *any* two objects which were used for the same purpose; or if paper were taken as a modern development of papyrus one would search for a pair of objects related not only in function but also in history; shoe-and-sandal would fit admirably.

[4] Th. Ribot asserted that "l'élément essentiel, fondamental, de l'imagination créatrice dans l'ordre intellectuel, c'est la faculté de *penser par analogie* . . ." (*Essai sur l'imagination créatrice,* Paris, 1900, 22). Thomas Brown noted the same thing. He ascribed the ability of observing analogies to "those whom Heaven has formed for the high destiny of . . . spreading improvement over all . . . generations of mankind." (*Lectures on the Philosophy of the Human Mind,* Newman, Andover, 2, 1822, 22). Both men realized that analogizing was an association of similars but that mere similarity was not enough to occasion the bringing together of two things. Brown observed large individual differences in the faculty, which he traced "in part, to original constitutional diversities, but also . . . (to) transient circumstances," (*op. cit.,* 242-243). Hence the genius was not entirely "heaven-formed," as he had earlier declared.

[5] See J. E. Creighton and J. Smart, *An Introductory Logic,* 1932, 313.

an unknown planet which was later 'discovered.' To be sure, we must not forget that many hypotheses arrived at by analogical inference have either never been verified or else have proved to be untrue. The value of 'reasoning by analogy' usually depends on the similarity of fundamental or relevant aspects of the phenomena in question.[6]

Many anecdotes concerning the formulation of scientific laws describe the man of science as witnessing a familiar event which suddenly suggests to him the universal and necessary character of certain relations apparent in the event. Archimedes lying in the tub, Newton under the apple tree, Bradley in the sail-boat, Thales observing a man's shadow, Watt with his tea-kettle, all—if the stories are credible—grasped the relation in the objects before them as obtaining in all similar situations.

Again, analogical product may mark the excellence of a literary work. Besides similes and metaphors, allegories and parables enrich the significance of the subject of discourse and vivify the author's observations. Other arts, too, usefully express analogical relations. Painting, sculpture, and the dance (music, more obscurely perhaps but just as really) display relations in a specific form which are familiar in other forms to all men.[7] In fact, one of the common claims to greatness for a work of art is its power to suggest this wider applicability and to suggest it to men of all ages.

The English associationists were among the first to consider relations from a psychological point of view, simply as products of the 'mind's' operations. They found in analogical relations neither discovery nor creation. The relation $a : b$ is, for them, just a kind of object and $c : d$ is another object associatively related to the first.

An early consideration (1893) of the analogy for its own sake and apart from its logical or epistemological references, appeared in a small book written by William Stern,[8] who noted its importance in everyday speech and sought to discover how one acquires or develops the ability to think or speak in analogical terms. His exposition is not based on experimental results but on his own observations. His interpretation is often in the terms of the associationist, although he adds an *"analogistische Ergänzung"* (chap. iii). He has written an interesting and thoughtful book suggesting motives for forming analogies, conditions under which they occur, classification of various kinds, their importance in the fields of genetic, social and linguistic studies, but without a psychological description of analogizing.

We have found only a few minor studies within our field. The earliest of these is by Karl Bühler,[9] who read to his subjects proverbs with analogical significance and found a tendency to 'understand' by a memorial reference to earlier statements in the series.

Woodworth used such problems as "London : England :: Paris : ?" and "the

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[6] For a discussion of the importance of analogy as an aid to formulating hypotheses but as an unsatisfactory mode of proof, cf. Creighton and Smart, *op. cit.*, chap. xvii. See E. L. Clarke, *The Art of Straight Thinking*, 1929, chap. viii, and H. Spencer, *Principles of Psychology*, 1855, chap. iv.

[7] We do not intend to say that all art is analogical expression but many are the examples of depicted relations in artistic symbols; see, *e.g.* G. G. Barnard's sculpture "The struggle between good and evil," Watt's allegorical paintings, and Stravinsky's "Sacre du printemps."

[8] W. Stern, *Die Analogie im volkstümlichen Denken*, Berlin, 1893.

[9] K. Bühler, *Tatsachen und Probleme zu einer Psychologie der Denkvorgänge*, III. Über Gedankenerinnerungen, 63.

hand : the fist :: a nation : ?"[10] His subjects reported 'feelings of relations' which were 'as simple and unequivocal' as any other 'elements' of consciousness. The missing fourth term came (1) almost automatically "with very little consciousness," (2) only when the relation between the given terms could be named and so guide the search for the missing member, (3) 'read off' from visual imaginations, or (4) from a 'felt' relation for which there was no name or image. Woodworth's general comment is that "in this form of exercise, the relation is suggested by means of two terms between which it holds, plus a third term which serves to indicate which of the possible relations between the first two terms is chosen. The relation must now be detached from the first pair of terms and transferred to another case. In the process of transfer, the relation sometimes does not exist at all in consciousness" (492-93).

Woodworth's statement leaves one in doubt about the ultimate nature of the 'feeling of relation.' What is it that is detached and transferred? Since the relation is a feeling, the feeling must be detached and transferred. But the feeling of relation which is first apprehended is directed to the relation of the two given terms; if it is detached from those terms, *what is it?* It is a feeling of relation of what? Add to this the consideration that while it is being transferred it may "not exist at all in consciousness," and you have fairly annihilated the 'feeling of relation'; a feeling not felt and a relation which relates nothing. Suppose, however, that the 'feeling of relation' *could* be detached from the members to which it is first connected, then, says Woodworth, it must be "transferred to another case." But the 'other case' consists of one term and a question mark which stands for what? How can there be a 'feeling of relation' until there are two things which can be related? Whatever Woodworth's 'feeling of relation' may be, it does not explain how one arrives at the unknown term by the mere statement that "the relation . . . (is) detached from the first pair of terms and transferred to another case."

Woodworth and Bühler are both preoccupied with problems beyond the analogy. Bühler refutes the Wundtian analysis of the 'elements of consciousness' and Woodworth argues for William James' contention that 'feelings of relation' constitute a fundamental part of the stream of consciousness.

In an article on the use of relations in thought, Carveth Read[11] refers to an exercise in which he read one member of an analogy and instructed his hearers to finish with a member from a certain restricted category (*e.g.* "mention two musicians who are to each other as blue to red" or "two dramatists who are to one another as Scott to Thackeray").

He found similes formed either directly through similarity of relation or indirectly through similar 'absolute effective impression' or through use of the same terms to describe two things. The absolute affective impression seems to be a synesthetic experience in which, for example, *O* identifies red with the music of Tschaikowsky or Beethoven, blue with Debussy's.[12] In spite of Read's criticism of the

[10] R. S. Woodworth, The consciousness of relation (in *Essays Philosophical and Psychological*, 1908, 485-507).

[11] C. Read, The function of relations in thought, *Brit. J. Psychol.*, 4, 1911, 342-385.

[12] Some of Read's items demonstrate no identity between relations but only similarity between single terms. He might as well have asked "Name a composer who reminds you of red and one who reminds you of blue."

associationists, the chief end of his work seems to be to account for the government of the course of ideas through similarity of the relation-between-given-ideas and others which they arouse.

Today the psychologist finds the analogy most frequently employed in 'intelligence testing.' The frequent use of verbal and pictorial analogies indicates a common belief that some kind of intellectual capacity is here in evidence. Analogical tests include such problems as these: "Underline the best of the 4 words in parentheses; cellar . . . attic: bottom . . . (well, tub, top, house); coat is to wear as bread is to (eat . . . starve . . . water . . . cook)."[18] In group-tests the analogical section may take the form of a list of general statements on one side of the page, a list of proverbs on the other, and the instruction to choose one of the former which will best explain each proverb. In non-verbal tests three pictures with a group of several others may be used to test the child's ability to choose one from the group which fits with the third picture as the second fits with the first. As to the way in which the organism actually proceeds to create, understand, and use the analogy, however, the authors reviewed do not inform us.

So far as we can discover there has been no attempt to study the processes of analogizing and the processes of creating analogical relationships in their own right and for their own psychological sake. Our proposal is to make such a study. The procedure will be (1) to invent occasions in which *O* may be induced to grasp analogies intimated in verbal or pictorial terms and (2) to secure standardized reports of the psychological operations and products involved.

In our initial set we employ simple verbal materials in the form of the proverb; first, the proverb which represents the $a : b$ relation to discover the corresponding $c : d$ member (Series 1, 2) and later the augmented proverb with the complete analogy—$a : b :: c : d$ (Series 3).

In the second set we use cartoons and drawings pictorially presented. Cartoons are used in which persons and objects are depicted in relations representing historical events (Series 4). Then follows a series of simple pictures of four objects which may be considered to be related analogically (Series 5). This corresponds in form to Series 3 but with simpler materials.

In the third set we proceed from simple analogies of four words, then three, and then two words, and go on to fragments of poetry which contain only the $a : b$ relation (Series 6, 7). These series are designed to

[18] R. Pintner, *Intelligence Testing: Method and Results*, 1931, 184. C. Burt asserts that he and Moore first used analogy tests (*Mental and Scholastic Tests*, 1922, 226). The authors' analogy tests seem to assume that the exercise calls for some specific kind of undescribed ability. W. F. Dearborn says that the "analogy test . . . depends for its answer on orderly and well-established associations. It samples the common experiences of mankind." (*Intelligence Testing*, 1928, 60). Burt asserts that the analogy tests "call forth the power of reasoning," the "very essence" of which is "perception of significant relations." F. N. Freeman also calls the analogies test "a measure of the ability to see relationships." (*Mental Tests*, 1926, 147.)

make a maximal demand upon *O*'s psychological resources. Variations are introduced into all series to discover the effects of context, familiarity, and form.

Set I. The Proverb

We first consider the proverb, a fairly simple and familiar form of analogy. It is a factual statement with an implication beyond the topic directly conveyed by the words, the immediate fact and the implication containing a like relation.

Regard, for example, the sentence 'You can't eat your cake and have it too.' Two different results may proceed from the reading. One is the relatively simple and immediate grasping of the sentence, which may be taken as an observation of the same order as 'There is no wind so you can't go sailing'—a straightforward remark with no 'deep' implications. Again, there may be the understanding that if some possibilities are realized other possibilities are eliminated. This is what is commonly called a 'figurative meaning.' It is taken as a functional outcome which may apply to situations other than cake-eating.

First we ask whether the two outcomes appear separately and independently of each other. Is our distinction between them merely logical, *post factum*, or has it a psychological basis? If the two are not separate, then the analogy is incomplete, containing only one member. As regards the 'deeper meaning' of the proverb, a verbal formulation of it may or may not be necessary. Will the phrasing institute a search or will the proverbial aspect be recognized at once in the recital? or, finally, Will the recital prime *O* for a further signification?

In any of these events we have further to ask what resources *O* draws upon to enable him to grasp the proverb. Does he take a 'symbolic' cue from a specific word or part of the sentence? Does *O* imagine, remember, inspect, comprehend or think? Does the sentence as a whole suggest the remoter meaning?

Series 1. Twenty-five proverbs were selected for their novelty to our *O*s, since familiar instances would already have taken on the 'figurative' signification which we mean to investigate at its origin.[34]

Ten proverbs were typed on white cards (4 × 6 in.), placed one by one on a gray rack before *O*. The only illumination in the room was a desk-lamp turned upon the card. Formal instructions were read:

[34] Our proverbs were taken from *A Book of Quotations*, W. G. Benham (ed.), 1907. The observers for the experiment were G. Longwell (*Lo*), M. S. Ryan (*Sh*), T. A. Ryan (*Ry*), and J. Macmillan (*Mc*), graduate students in psychology. Two additional observers, Cleo Chrisof (*Ch*) and R. M. Lindner (*Li*) served only in Series 1. Dr. Bentley (*Be*) made preliminary observations in all series. A list of the technical abbreviations used will be found on page 224, above.

Consider the material to be presented. Signal by tapping on the table when you are ready to report your procedure in functional terms.

After an exposure of 10 sec., the exposure-card was covered. *O* tapped when ready and proceeded to report. The time was kept (in sec.) from exposure to *O*'s tapping signal.

Fifteen additional proverbs were read to *O* as he reclined in a comfortable chair with his back to the light. With the aural presentation, *O* was not distracted by length of line, punctuation, and visual context.

Results. First to appear was the 'literal meaning,' the obvious significance of the sentence. This 'literal' sense was provided in two ways: (1) by an imaginational accompaniment of objects mentioned in the sentence or (2) it was reported to be a product of comprehending which accompanied or came just after the reading. Reports of imaginational accompaniment run as follows:

[Sentence scanned but not understood] > SI (memorize it before it is covered) > imag (drop of honey on plate; many flies about; big barrel of vinegar). [Taken as statement of fact: no task.] *Mc-1-1*[15]

Per (typed words on card) > insp (sentence reread); imag (one trying to whistle and drink) *Lo-1-8*

[Sentence read] > com ("yes") > SI (check that) > imag (ship being filled with water) *cum* com ("yes, it really can. A small leak could fill a boat") *Sh-1-5*

[Sentence read] *cum* imag (grocer's paper bag on a table on flat end with top leaning over) > com ("of course") *Ry-1-10*

The imaginational accompaniment is a kind of translation of the sentence into spatial form. When this form expresses the relation implied in the words, *O* assents.

The other mode of appearance of the significance was reported as 'comprehension' which either accompanied the reading or immediately followed it.

[Reading sentence] *cum* fl (just meant 'a hook's well lost to catch a salmon') *Li-1-2*

[Reading] *cum* comp (no, he isn't) *Li-1-3*

[Reading word by word in sentence form] > comp (two different things) *Li-1-4*

[Bare reading] > fl (that's the meaning!) *Ry-1-7*

Bentley emphasizes too much the use of language in the making and enriching of topics and he implies that all verbal material is comprehended.[16] He failed to consider words, phrases and sentences which do not "touch off topics." Word-labels may refer to *objects* and have no topical significance whatsoever. When one sees, for instance, a strange fruit and is informed that its name is 'mango' the word is nothing more than a label for mango-object. It is so often repeated with the apprehension of the fruit that the sound of the word practically becomes an attribute of the object. One need not pass "beyond the particular and the individual." We suggest that names and labels be classified as perceived objects. The fact that they signify events or things not directly apprehended by the mere pronunciation of the word does not in the least set them apart from other perceived objects. An article may be perceived as belonging to a person or an instrument as serving a certain purpose (*e.g.* a smok-

[15] After the initial of *O*, are given series and number. For the proverbs used, see Appendix (page 350, below).

[16] M. Bentley, *The New Field of Psychology*, 1934, 274-287.

ing jacket is perceived as Will's-jacket; a knife as knife-for-cutting-grapefruit or knife-for-cutting-bread)."[37]

The first group of reports given above (with *imaginational accompaniment*) suggests that the proverbs were put into apprehended objects and events and were not 'comprehended topics.'

We conclude, then, that we have here a 'literal' significance of the proverb, which we call the sentence-object, with or without apprehensional filling in imaginational form and with or without comments.

Beyond these activities and outcomes there is another product, the 'figurative' significance which proverbs are designed to call forth. This product came, with one exception, after the primary significance in point of time. Descriptions of it show that there is a decided qualitative difference between the two.

Per (sentence-object) > imag (baker with white apron; head a square of melting butter) > insp (imagined objects) *cum* comp (baker is symbolic of a topic) > com ("be careful in choosing vocations. Be sure to choose what you can do. Know thyself") > fl (this is what the sentence means) *Lo-1*-24

Per (part of sentence-object) > com ("can a dog know that they are preparing to kick him out") *cum* imag (dog about to be kicked out) > imag (shift to man-in-a-barroom) > fl ("well-bred" probably indicates that this sentence is an anthropomorphic statement designed to teach men a lesson. Therefore, you should probably substitute "man" for "dog") *Ry-1*-25

Per (sentence-object) > imag (brown bag lying limp) > com ("no it won't") > SI (tap, you have solved it); SI (wait: What about applying it to general behavior?) > fl (?) (a person who has nothing to him has to depend on someone else) *Sh-1*-10

Per (sentence-object) > imag (baker with head of butter by hot oven with head melting into bread which is coming out of the oven) > S (words for the concept back of it). [The concept was vaguely understood as "Don't take up a trade that you're unsuited for," but it wasn't formulated until now] *Mc-1*-24

Per (sentence-object) > imag (key to my office; girdle around a large stomach of a man) > imag (putting keys on girdle) > (?) (word "key" a symbol for opening to opportunities and experiences; girdle symbolizes man) > fl (one man does not have all opportunities) > fl (this confirms the truth of the statement) *Ch-1*-18

This 'figurative' significance is, it will be noted, of quite a different character from the sentence-object. It is a product which *O* describes in words not borrowed from the sentence. Many of the terms are now topical rather than objectival. Contrast, for example, 'brown bag' with 'person-who-has-nothing-to-him' (Proverb 3), 'baker,' 'butter' and 'oven' with 'trades' (4), 'key' and 'girdle' with 'man' and 'opportunities' (5).

Underlying these terms we find in the reports perceiving, searching, inspecting, flashing and comprehending. Self-instruction and comment give

[37] Neff has clearly demonstrated how perceiving may approach comprehending as the perceived object takes on new attributes. (W. S. Neff, Perceiving and symbolizing: an experimental study, this JOURNAL, 49, 1937, 376-418. Cf. M. Bentley, page 221, above.)

direction to search, both indicating progress toward the remote or 'figurative' solution. The product is invariably the 'meat' of the proverb, in the form of a general reflective observation on human life and conduct. The end-products are illustrated thus:

Fl (don't do anything where you would lose your head) *Sh-1*-24
Comp (authority [imagined girdle = authority] is never concentrated in one place) *Lo-1*-18
Comp (a small investment might bring large returns) *Lo-1*-2
Fl (a person who has nothing to him has to depend on someone else) *Sh-1*-10
? (don't take up a trade that you're unsuited for) *Mc-1*-24
Fl (one man does not have all opportunities) [girdle = man, key = opening to opportunities] *Ch-1*-18

These end-products of a final comprehending (or its equivalent) are usually formulated in what we may provisionally call single and unitary *sentence-topics*. As produced by functional antecedents they differ from such *word-topics* as 'genetics' or 'poverty.' We find no factual support for analyzing these sentence-topics into two things *plus* a relation. Such an analysis, we insist, is logical not psychological. The writing of a proverb obviously implies readers with resources adequate to the re-creation of the 'truth' which the writer means to convey.

The fact must not be overlooked that there is here also an intimation of the process of elaborative thinking. The 'figurative' significance is neither a product of what has been described as 'symbolic comprehending' nor a process of enriching a bare topic. The sentence-object, turned out at one moment by the organism, stands as a novel means out of which at the next moment the 'figurative' signification may emerge.

In all the examples of elaborative thinking given by Bentley, the organism starts with a task to find out *why* some event occurs, *how* it can accomplish some feat or *what* is the answer to a controversial question. Bentley finds that, in the formulation of a thought-task, "the organism already has knowledge which it seeks to extend. The thought-determination always is rooted in the individual's past experiences."[18] If we accept this criterion, then the performance of our *O*s cannot be called thinking.

The main task beyond the sentence-object was to 'discover its significance.' This task was usually set as an SI followed by S after *O* had received his first intimation.

SI (get away from the literal, 'Find some generalization') *Lo-1*-5
S (for remote meaning) *Mc-1*-18
SI (do the same thing I did before. Try to make a parable even though I hadn't comprehended any meaning) *Sh-1*-23
SI (meaning doesn't come by itself. Maybe I can do something about it) *Ry-1*-3

[18] M. Bentley, *New Field*, 302.

In true elaborative thinking the outcome of the process will answer a question either one way or another, will solve a problem set by the individual. Here, however, *O* has a task much more like that which initiates comprehending. He is primed "to seek further information about the object . . . under scrutiny,"[29] but, unlike the procedure of seeking further information in order to comprehend, he cannot rely upon inspection and inclusion to aid him. He must search for experiences in his own past or make other demands upon himself to reach the goal of producing a satisfactory answer to the question 'What does the writer of the sentence mean?'

It will be seen later that the secondary signification may come without any set task. This distinctly sets the performance apart from elaborative thinking. The process described here seems to be one which will produce novel symbols to aid in the progress of elaborative thinking; hence, it must be prior to, or involved in, the more complicated operation of resolving thought-tasks.

The described operation does not appear, then (at this stage of the experiments) to be exactly comprehending or thinking, but has characteristics of both. It is like the former in that the organism proceeds from an apprehended object to a topic, but it differs from comprehending in that the apprehended object is no conventional 'symbol' about which information can be obtained from other persons, from dictionaries, or other sources of classified knowledge. The topic is not a standard product. The performance has an attribute of elaborative thinking in that it involves a new symbolizing which produces something impossible to designate by any prescribed term. There is, however, no true thought-task, even though *O* must set his own tasks and resolve them from his own resources.

These results, especially if borne out in later series, suggest that we provisionally assume a specific function, which we may call *symbolizing* and which stands in the hierarchy between comprehending and elaborative thinking. Its typical course may be described from our reports as

Apprehension of sentence-object > intimation of remote significance > progress to 'figurative' or symbolized product through implications of imagined objects or otherwise.

The last step is still the most obscure, since our reports cast very little light on the antecedents to the final production of the final significance.

The sentence-object is symbolic only when it has come to intimate the final product. It is not related to the wider significance in the same way that a topical word is related to the subject which it labels, for when *O* is engaged in describing and clarifying the figurative signification the sentence-object is left behind, both its terminology and the event which it depicts.

This brings us to our second general question, How is *O*'s performance governed? Several governing factors appear in reports. There are three cases.

(i) The form of the statements was recognized as an expression characterized by a remote significance.

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[29] *Ibid.*, 286.

Com ("these all sound like proverbs") *Ry-1*-4
Fl (maybe this is a parable or symbolic tale) *Ry-1*-11
Comp (another allegorical statement . . .) *Lo-1*-23
Fl (perhaps these are proverbs which should be applied to more than just a specific interest, to general behavior instead) *Sh-1*-7

Lo actually named the form 'allegorical' long after she had established an SI to look for a remote signification. In spite of the fact that *Ry* early in the series recognized the form, his discovery was not an active governor in later items. *Sh* is the only *O* whose reported discovery was important as a later governor.

Rem (last time I thought that these might have some other meaning) > SI (look for it now) *Sh-1*-8

Although other *O*s did not name the sentence as a particular form of expression, there are intimations that they recognized the possibilities of 'hidden' significance from the very nature of the statement. That is, initial reading of the sentence resulted not in the labeling of the statement as a proverbial or allegorical expression but in an expression of dissatisfaction with the trivial nature of the apprehended sentence-object.

Com ("what a silly statement") > S (something more than appears) *Mc-1*-11
[Irritation] > com ("how silly!") > SI (what could 'head of butter' mean allegorically?) *Cb-1*-24
Com ("of course all keys are not on one girdle. Why should they be? This is trivial") > SI (find some hidden or symbolic significance) *Ry-1*-18

The discovery that the simplicity of the statement may be a false front, as it were, is really a recognition of the proverbial form without naming it as such. Proverbs are characteristically observations of simple fact presumably obvious to any one who has had the opportunity to witness what is being described, but they point to something beyond the described event.

There are also sudden intimations of a 'wider meaning,' which occurred without any reported antecedents.

Imag + rem (incidents about salmon) > fl (the sentence has another meaning) *Lo-1*-2.
Imag (eagle's beak grabbing for something) > comp (the flea is too small for the eagle) > fl (this has a larger symbolic significance) *Ry-1*-21

Products served here as governors which started a search for suggested signification.

When the report of psychological performance was completed, *O* often expressed dissatisfaction with his procedure, *i.e.* he had some intimation, though vague, that he had not reported everything. All *O*s mentioned this; during the whole series it was reported twenty-one times. While it was not a governor which initiated a sharp change in the course of performance, it did create a background of anticipation which maintained search.

(ii) Besides occasional or self-instruction following recognition or suspicion that the sentence had a significance other than the sentence-object, there also occurred suddenly, when the sentence was first read and without any direct antecedent, the product of 'figurative' significations.

[Read sentence] > rem (incident in which I was 'the leak' and hoping no ship was sunk) > imag (large ship with rats leaving it because of a small leak in the

hold; the ship sinks slowly) > SI (get away from the literal and find some generalization) *Lo-1*-5

Lo reports only a product of remembering but clearly she grasps something more than a remark about sinking ships: the remembered event did not concern ships but is merely reported in these figurative terms. She goes back to the 'literal' significance which is carried by imagining and comes later to the possibility of making a 'generalization' from the statement. This supports our discovery that the 'literal' and 'figurative' significations are separate; but it also indicates that the order of their appearance is not always the same. This example is, however, the only one of 125 reports in which the sentence-object was not apprehended *before* the other.

(iii) The function was 'governed' away from the 'literal' significance through imaginational products. Either the apprehended *object itself changed* into another object or else it was taken to *stand as a symbol* for something else.

For example, in Proverb 25, the imagined dog changes into a man, thereby leading into the 'figurative' significance. *Ch*'s and *Lo*'s imagined objects, on the other hand, went from mere apprehension into a grasping of something beyond those objects. The objects themselves took on a derived significance and pointed toward other products. Such a procedure occurred six times in the course of the series and was reported by all *O*s. Besides the examples already given here is one from *Mc*.

Comp (well-bred dog) > imag (dogs at home) > comp (rest of sentence); imag (man leaving a place). [The (non-verbal) imagination carried the meaning that a gentleman leaves when he sees he's not wanted.] *Mc-1*-25

In summary, we have found three sorts of governing factors which effect changes in course, directing the operation toward a 'figurative' significance. (i) Self-instruction which may arise from (a) recognition of a literary form which characteristically has 'deeper' signification, (b) from dissatisfaction with the trivial nature of the sentence-object, and (c) from a sudden intimation through a flash or comprehending that there was more to be discovered than the apprehended sentence-object; (ii) Reading of the sentence itself may be an occasion for the production of the remote significance, and (iii) Imaginational products with symbolic designation may appear as a step in the progress toward the end-product.

Results thus far reported have yielded some information upon our third general question, which concerned the resources called upon by *O* in turning out the 'figurative' significance. Examples have shown that intimations of the far-reaching import of the sentence may come from *O*'s past experience with proverbs. This is the only reported use of historical background. Having received this intimation, *O* seeks to discover the remote significance, but reports are singularly lacking in evidence of the means which he uses.

Comp (the sentence had another meaning) > com ("a small investment might bring large returns. Banking money or investing energy or work might bring returns later in the way of recognition or a job") *Lo-1*-2

S (for the 'concept' implied) > com ("what it really means is keep something in reserve. There is another proverb that expresses it. A bird in the hand—don't put all your eggs in one basket"). [The concept never did arise.] *Mc-1*-20
Rem (last time I suspected that these might have some other meaning) > com ("this simply means you can't do more than one thing at one time"). *Sb-1*-8 [Questioned on what brought the comment! "It just came in verbal form. I can't say what brought it."]

These reports are not helpful in answering our question. The figurative product 'just came,' as *Sb* said, immediately upon searching for it. From these reports the process seems to be simply as if someone said "Look at the red bird" and one had but to turn one's head to behold the object. We cannot infer from the simplicity of the report, however, that the process was so uncomplicated.

Lo once described the process a little more fully.

Imag (large pottery jar sitting beside an Indian home) > fl (I know what this means) > SI (find words to express this knowledge) > com ("it's well to keep useful utensils even though the immediate need for them is relieved through a gift or unexpected source"). [There was a background of stuff coming with the flash which was not verbalized. 'Preparedness,' 'caution,' 'looking ahead' was the essence of it.] *Lo-1*-7.

Lo here grasped the suggestion that one must anticipate the future and she realized its general application to all events in which one possesses an instrument which may not be useful at the moment. The relation of the watering-pot to rain was apparently taken as the same relation between other utensils and occasions on which they appeared to be superfluous. We have here an indication that the apprehended *relation,* not the 'symbolic' reference of objects named, is what directed the performance from one product to the other.

We also find (as Bühler had) that, having reported the 'figurative' significance as a general observation which described many situations, *O* further clarified the relation by giving examples of other specific occasions which demonstrated the same relation.

Fl ('diseases' might be any sort of wrong to individuals or to countries) > com ("take for example the war in Spain and the strong methods that had to be used to remedy it") *Sb-1*-22
Comp (there are certain things that are to be done one at a time. Whistling and drinking are good examples) > (search for more) > com ("you couldn't roller skate and fly an airplane at the same time") *Lo-1*-8

Nothing positive can be derived from these results. In view of the fact that there were relatively few products of 'figurative' signification, (26 from 125 proverbs), we cannot hope for a great deal of information concerning their sources. We hope that later series will help us.

Lo, who most often gave these illustrations, apparently mentioned them only to elaborate and clarify the significance which she had earlier reported in general terms. In *Sb*'s report, however, the example of 'war in Spain and desperate remedies being made' was the only reference to a figurative significance. It does indicate that she grasped the relation stated in the proverb and saw that it was applicable in other circumstances than the sick room. The remote signification, then, may be marked by *O* in two ways; by direct attempt at 'explaining' what it means in general terms (*e.g.* "It's well to keep useful utensils even though the immediate need for

them is relieved") or in noting other instances in which the same relation holds (*e.g.* "Take as an example the war in Spain. . . . ").[20]

In this series were notable individual differences in the performance, products, and length of time *O* occupied himself with the proverb.

Lo's reports were characterized by many more products of general or figurative significance than the others'. She gave more examples and took longer in her consideration of the sentence. In the second item of the series she grasped the fact that there was a subtler 'meaning' to the statements than first appeared and thereafter always looked for it.

Sh also grasped a number of the 'general meanings.' She was slower in finding the indications of such a thing, not reporting any until the seventh item. She was fairly consistent in instructing herself to look for the deeper significance except for one day when her performance was not at all satisfactory either to herself or to *E*. She ran into blocking and confusion and could make nothing of any of the sentences. *Sh* spent much less time on the sentences than Lo.

Mc was peculiarly reliant on visually imagined objects to illustrate the *'meaning'* of the sentences. He went beyond the literal only three times.

Ch considered the proverbs very briefly, even after instruction from *E* to spend more time on them. The fact that she was less familiar with the mode of report made observation rather difficult. More often than any of the others she expressed dissatisfaction with her performance, saying that she believed there was much that she was not grasping.

Ry's reports are dominated with impatience with what he considered 'absurd statements.' Even after he recognized them as proverbs, he failed to let that knowledge change his performance. *Ry* observed late in the afternoon and fatigue undoubtedly affected his observations.

Conclusions. (1) There are two distinct products which result from the consideration of unfamiliar proverbs. The first, 'the literal meaning,' usually appears directly upon reading the sentence. We have described it as an apprehended *sentence-object*. The second, commonly known as the 'figurative meaning,' appeared, with one exception, later in time than the sentence-object and was characterized by description in general terms which made it applicable to many situations.

(2) The mode of appearance of the secondary significance suggested that there may be a function of *symbolizing* which is closely related to comprehending and elaborative thinking, yet differing from the former in that

[20] We are doubtful whether weight should be given to an assertion that *O* 'knew what it meant' but couldn't verbalize it. *Ry* had this experience several times (*e.g.* "the whole sentence took on a significance but I can't put the significance into words now. It was like a flash (I know what it means)" *Ry-1-9*. Since there is nothing to indicate the nature of this significance, we can merely mention the report as illustrative of possible grasping at figurative significance as a product which cannot be verbalized.

there are no conventionally accepted 'topics' to describe its product and from the latter in that the task which initiates it is not a thought-task.

(3) The factors which initiate and maintain symbolizing may be historical resources of the reader which enable him to apprehend the sentence as an object having potentialities for symbolizing.

(4) The symbolized product appears very suddenly once the implication is recognized. Further investigation may throw more light on the process of its creation.

Series 2. To establish an occasion which would call forth more products of figurative significance, a series of 25 proverbs often appearing in conversation and writing was arranged. It was assumed that *O* was sufficiently acquainted with these to recognize in all a figurative reference. We anticipated that such a series would (a) test our supposition that the deeper significance might appear without the sentence-object or 'literal' signification, and (b) would throw light on the nature of such a product.

The proverbs were read under the same conditions and with the same instructions as before.

Results. In Table I our results are compared with those from the first series.

TABLE I

A Comparison of Observers' Reports in Series 1 and 2

	Series 1					Series 2				
	Lo	*Sh*	*Ry*	*Mc*	*T'l*	*Lo*	*Sh*	*Ry*	*Mc*	*T'l*
Sentence-objects	14	20	17	18	69	21	13	16	21	71
Figurative signif'ce	16	6	1	3	26	20	20	7	20	67
SI Fig'ive signif'ce 'Dissatisfaction'	9	10	5	5	29	3	3	2	4	12
Fig'ive signif'ce 'Symbolic' products of Apprehension	5	7	7	3	22	3	5	10	2	20
	3		1	1	5	7	4	10	7	28
Other analogies	9	1		1	11	2	1	5	3	11
Av. time (sec)	67.8	14.1	27.9	22.0		64.6	7.6	35.8	12.1	
Time-range (sec)	35–163	3–35	5–51	11–40		22–148	4–16	18–68	4–29	

The number of sentence-objects was about the same in these two series (69 and 71): figurative significance greatly increased (26 and 67).

Per (familiar sentence) > com ("you can't get money from a Scotchman") > SI (you shouldn't have said that without giving the significance of the statement) > com ("it means you can't get something out of a thing which doesn't have it"). [What I know is already there as soon as I perceive it as familiar] *Sh-2*-10

Comp (proverb) > imag (school room full of small children; small children in house overhearing conversations not meant for them) > insp (imaginational products) > S (words to generalize) > com ("the proverb is generally applied to children who are present but disregarded") *Lo-2*-19

Comp (that familiar sentence) > com ("what am I supposed to do with it?") > SI (define what it means). [There suddenly. It might be called an experimental in-

struction.] > S (no particular direction) > rem (talking about the all-or-none law) . . . *Ry-2*-2

Imag (Rome and St. Peter's, Romans in togas) > com ("oh, that darned thing again!") > rem (various places where I've seen this put into effect when people comply to social custom) *Mc-2*-11

There is a distinct change in function marked by these examples. The function described here is not symbolizing but comprehending. There are not two object-outcomes and a transition between. Reading of the sentence is accompanied by, or goes immediately into, the 'figurative' signification, which, in this case, is truly a topic for comprehension as defined above. The proverb is a conventional indicator for topics of (*e.g.*) caution-needed-against-alertness-of-children and desirability-of-compliance-to-custom. In the first three examples there was absolutely no reference to any of the words included in the statement; the fourth included the imagining of objects named in the proverb (the city and its citizens), but it was not a sentence-object in that it did not account for the admonition to imitate the ways of the citizens.

Further reports clarify the nature of the relation of the figurative significance to the apprehended sentence.

. . . [the larger meaning was as inherent as the comprehension of the meaning of a word from the sight of its letters.] *Sb-2*-11

Per (words) > rem (cooks in a movie) > imag (five persons trying to get their hands into a radio set all at once) > com ("that's it; it's self-evident") *Mc-2*-16. [E: What is self-evident? *Mc:* "the meaning; the meaning that 'too many cooks spoil the broth.' Don't you see?"] (?) (it means what it says; that you can't keep a thing and still use it up.). [This was non-verbal. It was passed off more with an 'oh it's self-evident.']

Mc's oblivion to the fact that he was not reporting anything to the experimenter by merely repeating the proverb was amusing. Obviously, the proverb did have significance for him, but his account of it was not enlightening. He seemed to resent pressing questions, considering them foolish.

All the reports substantiate our view that the recital of the familiar proverb is taken as a label for a topic, just as a word labels a thing or subject. The organism is no more concerned with the separate words, or even with all the words in their conventional signification, than it is concerned with the perception of separate letters or of the sound of the word 'osmosis,' which likewise is a topic-name. The organism does not search for the figurative significance as it did with the unfamiliar proverbs. There are also few cases of self and occasional instruction to derive the signification of the 'familiar.'[21]

[21] In some cases, however, there was self-instruction to search-for-something-not-immediately-apprehended. Cf. Bühler's *gedachthaben*. When Bühler's *O* encountered a maxim which was familiar, he sometimes recalled the *significance* of another proverb which pointed to the same thing; sometimes recalled the proverb and went again through *the process of discovering its significance*. In our experiment there is perceived familiarity but no remembering of the process which took place when the proverb was earlier encountered. The effect of the previous *gedachthaben* makes itself evident, however, in the reduced time which characterized the results of this series in comparison with the longer process of making an original discovery in Series 1.

Where the sentence-object is ignored as an apprehended product there is obviously no analogy; for there are not two members to be set by the analogist against one another. The sentence as a whole stands as a label for a topic, and the only relation which appears as a psychological product is the topical issue. A proverb is a member of an analogy only when the reader of it finds in the statement a relation which is identical with a relation of other objects in other circumstances.[22]

We anticipated more reports of figurative significance than appeared. Some reports hinted at it without quite realizing it; *e.g. Ry* often indicated that he had some 'understanding' of the proverb but could not verbalize its significance.

Fl (I know the significance; it's been there all the time but I can't do any more with it) *Ry-2-4*

Fl (the meaning is all right there in the sentence. Can't go any farther) *Ry-2-9*

Com ("I've always taken for granted what this means but I don't really know") *Ry-2-15*

Fl (this doesn't usually mean anything in the ordinary way in which it is used. It just smooths things over without having particular significance) *Ry-2-22*

Have we here real proverb-products? The 'understanding' was not enough to initiate search for words or other demonstrations, yet it is important as a description of the way in which, in reading familiar phrases, we pass over them at times with the merest hint of what they point to.

As in Series 1, apprehended objects remembered or (more often) imagined, appeared to represent or point-to the figurative significance. In Series 1 these products were truly symbolic (*e.g.* a key was a surrogate for opening-to-opportunities, an empty bag suggested a weak man). A few like instances occurred also in the second series. Here, however, products of apprehension served more often as representatives of the figurative significance than as steps in the transition from 'literal' to 'figurative.' They illustrated the figurative significance in a particular situation.

Imag (large group of birds with same feathers flocking together). [No further inspection or comment] > imag (human beings in different groups according to their professions—doctors together, lawyers, criminals, psychologists, etc.) *Mc-2-5*

Comp (sentence) > insp (topic of missing-things) > imag (baseball game in which batter misses). [Carried the meaning of the whole proverb]; fl (this is applicable to many situations) > fl (thesis is another example) > com ("certain things must be done to my thesis") *Lo-2-2*

Comp (sentence itself as a topic) > rem (old people learning to play the piano). [This was not a going-on from what was stated in the sentence but dealt with things related to the topic] *Ry-2-12*

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[22] One item of this series was unfamiliar to *Lo* and she actually did analyze the relation expressed in the sentence-object and identify it with the relation in the figurative significance:

imag (shoes that pinch me); SI (rephrase this proverb) > com ("as one's foot conforms to the shape of a shoe and is also molded by it, so does one have to conform to customs and traditions; the price paid for this conforming is known only to oneself") *Lo-2-24.*

This may be neatly expressed diagrammatically as shoe : foot : pinch : : tradition : individual : unhappiness at conforming.

These examples indicate that the procedure of the *Os* was to comprehend a topic from the sentence and elaborate it with illustrations, instead of trying to describe the topic itself. The subject under consideration was a thing "about which various things may be said and which may be illustrated by an indefinitely great number of instances."[23] That is, it was truly a topic (as Bentley has defined it) which was comprehended by *Lo* and *Ry*.

The decrease in average time spent upon the second group may be accounted for by facts mentioned above; namely, that *O*'s chief task was to formulate significance into words. The lengthened time for *Ry* is due to his rapid dismissal of the proverbs in Series 1 which he considered trivial or meaningless. In the second series he found more to engage him and was occupied in the task of verbalizing the products discovered.

Conclusions. (1) Proverbs which have been encountered in a context of conversation or writing are oftener grasped in their figurative significance than similar unknown and isolated proverbs. The function employed in dealing with them is typically comprehending rather than symbolizing, which occurs with unfamiliar material.

(2) If familiar proverbs are described as analogies most of them may be considered so only logically. Reports in psychological terms of the organism's transactions with such forms indicate that the sentence as a whole signifies something to the reader apart from any objects named therein. Recognition of identical relations present in the two products is rarely realized; indeed, there is often no separation into two products which compose the two members.

(3) There is evidence that familiar phrases are often passed over without giving more than a bare suggestion of significance. When confronted with the task of defining their signification the organism may be utterly at a loss. Much that we profess 'to know' in a typical way has no more *actual knowledge in hand* than we found here.[24]

(4) The figurative significance of familiar proverbs is often reported in terms of examples which illustrate the topic. On the other hand, *O* attempts to 'explain' proverbs which are new to him by describing the topic itself.

(5) There is a saving in time in the consideration of familiar proverbs as compared with the regarding of those which are strange.

Series 3. The proverbs of Series 1 were now repeated, each preceded by an illustrative 'statement' similar to examples *produced* in Series 2. The statement described a particular situation which might stand as an instance under the proverb.[25] Thus *O*

[23] Bentley, *op. cit.*, 275.
[24] *Op. cit.*, 278.
[25] The illustrative sentences were composed according to *E*'s interpretation of the proverb. As we have said, there can be no proof that this or any other is the sole or 'correct' interpretation.

is confronted with a complete analogy; for the terms in the illustrative material express a relation identical to that of the two terms in the proverb which follows. Does *O* discover this identity of relation? If so, does it aid him in reaching the general significance to which each member points?

Twenty of the proverbs used in the first series were repeated. Here is a sample.

"After Eric told her that he loved another she was in despair, but when she met Richard two months later she had no regrets that she was free and unattached. Every cloud has a silver lining." The relations here involved may be recorded in our analogical scheme as Separation from Eric : freedom to take Richard : : cloud : silver lining; *i.e.* the separation was a cloud in one aspect, an opportunity in another.

In order to keep the reports as simple as possible *O* was asked to give only the functions and products which occurred upon hearing the proverb, and he was limited to 3-sec. after the reading was finished. Longer times (up to two minutes and more) had often brought irrelevant imagining and remembering. It was anticipated that the short time would aid *O* in focussing his consideration upon just what was read to him. Items of this series were read as before and were preceded with these instructions:

Consider the material to be read to you. I shall tap on the table at one point in the reading. Report only the functioning which occurs after the tap. Begin to formulate your report as soon as the signal 'now' is given.

The tap was given just before the proverb was read, and the 'now' 3 sec. after the reading had stopped. One trial item (the example given above) was read to familiarize *O* with the procedure.

Results. (A) Products. From the 80 trials (20 for each *O*), the preliminary statement (s) and the proverb (p) stood related in 61 reports. Descriptions of this relation were various. Attempts to describe their connection resulted in the observation that (p) came variously as:

A comment on (s) *Ry-3-4*
A restatement of (s) ["as though you had said something and then said it over in other words"] *Ry-3-12*
Follows along the idea of (s) *Ry-3-13*
A summary of what had just been said *Ry-3-19*
A generalized statement for the specific instance in (s) *Sb-3-1* and 4
A figurative statement for (s) *Sb-3-12*
An allegorical generalization of (s) *Lo-3-2*
The same 'meaning' as (s) [an analogous relationship between the two] *Lo-3-9*
The same general application as (s) *Lo-3-15*
Applicable to (s) *Mc-3-3*, and as
Fitting with the other *Mc-3-8*

Such descriptions offer difficulty to an attempt to classify in psychological terms. Nevertheless, all imply that there are two distinct parts and that they are somehow similar. This recognition of similarity is not substantial evidence, however, that *O* recognized the analogical character of the item, for there is no reference to the relation expressed *within* the two members.

Investigation of products, aside from these comments of *O*, indicates three general products which carried the relation of the two parts.

(1) The *analogical relation* was three times described and actually named once.

Com ("Eleanor's behavior served as an example for the other girls"); insp (second statement) > com ("wreck serves as a warning to other mariners that here are hidden shoals") > insp (each of my restatements) > com ("each incident served as a guiding factor in determining the behavior of other individuals") > imag (spatial schema including my generalization, my restatements, your 2 statements) *Lo-3*-10

["The second statement seems to say the same thing in different words. It doesn't really stand for it. It's more like an equation in which the two sides are equal, as A + B = a + b"] *Sh-3*-14

Com ("oh yes, she was an example to the other girls just as the ship is an example to other ships, a warning") *Mc-3*-10

Lo's report is a nice exposition of the progression from symbolization of relation expressed in one statement, symbolization of relation contained in the other, to realization that the two are the same. *Sh* and *Mc* likewise indicate the grasping of the analogical relation, although their analyses are not so complete.

(2) Most of the reports of similarity between (s) and (p) reveal that the relation was recognized, not through a step-by-step approach from each part separately to a product which united them, but through an abbreviated process of turning out *one psychological product which stood for both parts.* This product took various forms, a (kinesthetic) imagining, a single word or phrase, an ambiguous word which could be applied to objects in either (s) or (p), a statement using words from both parts, or an explanatory statement which described the common significance of the two parts.

First consider examples where an imaginational product or a single word unites (s) and (p):

[At the tap there continued] > imag (Lincoln on stage of an auditorium with someone from the audience heckling him) > per (words of proverb) > imag (Lincoln with sword duelling an unseen opponent in the audience). [This imag carried the meaning "A man sure of his ground does not indulge in petty quarrels." It is applied to both statements] *Lo-3*-13

[Comp (last part)] > imag (facial expression which had also accompanied the first). [The relation of the proverb to what had gone before seemed all summed up in the imagined facial expressions.] *Ry-3*-15

Com ("pragmatic"). [The word seemed to be shorthand for the whole saying] *Ry-3*-17

Comp (general significance of proverb and its connection with the first part). [This seemed to be carried by the word 'flattery'] *Sh-3*-7

The first two instances of products of imagining provide the common meeting point. In the third and fourth instances a single word is taken as a description of (s) and (p).

Besides choosing such a topical word as 'flattery' or 'pragmatism,' *O* also had the opportunity to use words which ordinarily have both a 'literal' and a 'figurative' significance.

Com ("windbag"). [This seemed to carry the whole idea] *Ry-3*-14

Com ("as you can make an empty bag stand for a while, so some people can hold an unsuitable job only by support from someone else"). ["Support" is applicable either to the person or to the sack] *Lo-3*-14

Com ("how does this fit the other? Oh yes, the fellow didn't know anything; there was nothing in him to pass on to others. He was just a bag of air") *Mc-3*-14

Com ("poverty: turning"). [This meant that poverty was the turning of fortune] *Ry-3*-20

Note that 'windbag' and 'bag of air' are figurative phrases often used to refer to something other than real bags; 'support' can mean physical or moral support; 'turning' may mark a change in spatial direction or in a course of events. Our language is filled with such versatile terms; later series bring them out even more clearly.

Another interesting example of the flexibility of language is found in a report in which *Ry* endows a word with figurative significance for his purposes of the moment. Taking words from (s) and (p) he states "Mozart wasn't standing on anyone's shoulders" *Ry*-III-5. Apart from the context in which it was used, such a statement would have little significance, as there is no convention by which 'standing on shoulders' designates, as it does here, taking advantage of another's help.

By far the most frequent manner of noting the relation of the two parts was in the report of a sentence which stated what *O* took to be the common significance of (s) and (p). About one-third of all reports which noted a relation between the two expressed identity of signification.

Comp (second part is a figurative statement for the first) > com ("can't do two things at once"). [This carried the meaning for both] *Sh-3*-12

Com ("the individual has to break away from the apron strings.") [This was a repetition of the comment which accompanied comp of the first part] > fl (the last part can be explained by the first part or *vice versa.* They mean the same thing. The latter is allegorical as a generalization of the former) *Lo-3*-2

Rem (river between mountains in Alps). [(s) seemed to fit perfectly into the mountain scene. They both contained direct opposites] > fl (exact opposites get along well) *Mc-3*-9

Besides noting the identical *significance* of (s) and (p), the statements were classified as belonging to different *categories.*

[All these are rather similar. All at once (p) is comprehended immediately in its figurative sense and (s) is taken to be a specific instance of it] *Sh-3*-20

Comp ((p) gives in general terms what (s) gives specifically) *Sh-3*-1

Lo's report above indicates that she also took (p) to be "a generalization of the former [sentence]."

Other *O*s do not make this distinction but give (s) and (p) the same status.

[(p) = "merely a restatement of what had gone before"] *Ry-3*-12

["There is a complete similarity between (s) and (p)"] *Mc-3*-8

Com ("the politician and whistler were both trying to stand on both sides of the fence at once") *Mc-3*-12

Com ("a good swordsman doesn't have to pick fights; it was the same with Lincoln") *Mc-3*-13

Both of these interpretations may be considered correct if it is noted that one member *is* a restatement of the relation expressed in the other, therefore (s) and (p) are in a sense 'equal,' and it is also true that 'hook' and 'salmon' differ from

'million dollars' and 'advertising' in that the former are preceded by the indefinite article and lack the particular reference which the latter have. They may stand for *any* hook or salmon, but the others refer to *the* money and advertising of *the* directors.

(3) Besides the identity of the signification of each part considered as a whole, there was discovered a *relation between the corresponding terms of each member* of the analogy.

[No comp] > S (same sort of thing I've found before) > com (" 'house' is the same as 'business firm' but what is 'ride on the ridge?' ") . . . *Sh*-3-8

Comp (*p* means the same as *s*) > OI (find out how the two are related) > fl (*p* gives generally what the first gives specifically. The $1,000,000 is a hook; the people who buy the material are the fish). [I can't say just how this came. It was a summing up.] *Sh*-3-1

Comp (proverb) > SI (what does it mean in general and what has it to do with this specific case) > com ("poverty; turning"). [This meant poverty was a turn of fortune] *Ry*-3-20

SI (compare *s* with *p*) > com ("yes, there's a definite relation. The little leak represents one-person-intimating; the ship represents Mr. Pratt's office") *Lo*-3-4

Com ("that saying is very appropriate to the occasion mentioned, the honey being likened to Lord A., the vinegar to the other lords, and the flies to the queen") *Mc*-3-7

What is the nature of this relation of a term in one part to a term in another part? *Sh* and *Ry* say that the one *is* the other; *Lo* calls it 'representation' and *Mc* labels the one as 'being likened' to the other.

Mc's statement seems to be the most precise, although, of course, there is no suggestion from the item read to him that Lord Ashley is *like* honey or the other lords like vinegar. Such a conclusion is a result of *Mc*'s own consideration. The fact is that the one has attributes of the other *in that their relation to other terms of their own members are identical.*[36]

Some of these discoveries of corresponding members came after the similar relations of (s) and (p) had already been reported, hence they cannot be considered as anything more than aids to clarify a connection already made by *O*. On the other hand, some result from search for that which will bring the two together. *Ry*'s identification of poverty with a turn of fortune and *Sh*'s comment that " 'house' is the same as 'business firm' " show the direction in which they were proceeding. The members had to be considered *as a whole* in order for *O* to turn out the signification.

(B) Course of procedure. Symbolizing often characterized the procedure of *O* (as in Series 1). The sentences given were of the same nature as before: they were statements of objects or persons in a certain relation, the apprehension of which might lead *O* to find a wider significance in which he realized that the described events were representative of many situations

[36] In effect, these are statements of the analogy in a form other than that which we have suggested. Instead of saying a : b : : c : d, *O*s have said that a : c : : b : d which is still a correct statement of proportion. Where we anticipated, for example, that *O* would leak : ship : : intimating person : Mrs. Pratt's office, *Sh* reports leak : person : : ship : P's office.

involving the same relation. There was no conventional signification of the illustrative sentences which could account for the production of the generalizations which *O* did make. "He is for sober research and she likes to be with people, but their marriage is successful," "the politician wanted to please everyone and yet carry out his platform to the letter." These are observations of particular people and might be taken as mere statements of fact. Yet they were not. In only one case, *O* reported that the figurative significance of (s) had been grasped before (p) was read.

Com ("the individual has to break away from the apron strings"). [This was a repetition of the comment which accompanied comprehension of (s)] *Lo-3-2*

There were many intimations that *O* had taken (s) as more than a passing comment and had grasped in it a relation which held in many situations. Consider the following reports which show that the connection between the two parts was built up before the second was actually read; an event which would have been impossible had *O* been concerned only with an observation on the marriage of a particular pair, or the intentions of a certain politician.

Imag (colt with its mother) *cum* antic imag (what was coming: it will have to break away) *Sb-3-2*

Comp (empty bag as something which is hollow, nothing to it, stupidity) > antic imag (the rest of the second sentence would have a connection with the fact that the man was asked to leave) *Sb-3-14*

Comp (hook). [Vague anticipation of what was coming. This was not really formulated. It was anticipation of the significance which was to be attached to the word 'hook' in this connection] *Ry-3-1*

Comp (although it rain). [Vague anticipation of what was coming.] *Ry-3-6*

Such tuning is, of course, an important governor of performance. The organism is set to find a certain thing. It is no wonder that the significance of the once meaningless proverb is immediately grasped without search and is at once taken as being closely connected with what precedes it. As a matter of fact, the general signification has here been produced before the statement has been read; reading merely fulfills *O*'s expectations.[27]

Results from this series show that two symbolic statements, each with unrealized potential signification, may be placed against one another, as it were, without prevision, and aid the organism to get significant products from both.[28] Examples show that juxtaposing the two parts results in the recognition that they have the same significance and that this product *is an issue of their juxtaposition,* coming not from the consideration of either part separately.

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[27] This sort of projection into the future is closely related to primitive searching.

[28] The facilitating effect of the two appearing together suggests the process Woodworth describes of giving three terms of an analogy to indicate by the third term what relation (of several possible) is to be considered in the first two. *E.g.* onyx : cotton :: iron : ? indicates a relation different from that in the proportion onyx : cotton :: tar : ? Woodworth, *op. cit.,* 490. In the same way the introductory sentence suggested the relation *O* might find in the proverb.

Rem (review of first part) > $insp_m$ (second part as you had read it) > com ("yes there is a relation") > S (words to explain it) > imag (river and mountain together) > com ("complementary points of view are often satisfactory"). [This is what both statements mean] *Lo-3-9*

[Compare this report with the observation when the proverb alone was read in Series 1. Imag (mountains and rivers) > com ("where there's a mountain there's apt to be a valley; river will be fed by streams from the mountains and woods at the foot of the mountain will be watered by the river")] *Lo-1-12*

Imag (man sitting on roof of house; man walking into door of house). [These two were contrasted; together they were more or less explanatory of the sentence. They meant that one doesn't sit on the roof of one's house and if one did it wouldn't mean anything about one's regard for the house] *Ry-3-8*. [In Series 1 there had been only imag (man astride roof) > S (what it might symbolize). *Ry-1-11*

Rem (river between mountains in Alps) > rem (first part of statement which seemed to fit perfectly into the mountain scene) > comp (they both contained direct opposites) > fl (exact opposites get along well) *Mc-3-9*

[In Series 1 the report had been imag (river running down mountain) . . . [They did seem to go together]. Com ("almost every mountain has a river") *Mc-1-12*]

. . . com ("yes, this fits in"). [This comment indicated that the proverb expressed in general terms what the first expresses specifically. What I comprehended was a generality—not anything pertaining to a sword and arguer; it is a figure of speech.] *Sh-3-13*

[In Series 1 there had been imag (person fencing) > fl (no, a swordsman doesn't quarrel) > com ("a swordsman comes to the point")] *Sh-1-9*

A comparison of reports from the various series clearly indicates the change which takes place when the proverb is encountered in context. Where it had once brought forth only imagining of things named in the sentence, in Series 3 it is taken to be illustrative of relations discoverable in other situations—either in the one described in the sentence preceding it or else in any circumstance where the relation might obtain.

The influence of the context employed in this experiment suggests how a proverb acquires conventional significance which may be comprehended at once, instead of standing as a proverbial symbol with vague intimations of remote signification. The proverbs one hears in conversation often come, as they came in this series, after a particular event or occasion or after its description.

Not only may context offer the means for creating a conventional significance; it greatly facilitates symbolizing. In Series 1 only 21% of the reports showed the grasping of figurative significance while, in Series 3, 61% indicate the same thing.

Conclusions. (1) The relation between the two members is discovered. There is seldom a description of the two statements as an analogical proportion but the sameness of their significance is noted and the relation of corresponding terms in each member often pointed out.

(2) When a proverb is accompanied by a description of other circumstances, demonstrating the same relation which the proverb contains, it is

oftener taken as a symbol which points to wider implications than when it is encountered in isolation.

(3) Context may enable the reader to anticipate the signification of a proverb.

(4) When an analogy, complete with four terms, is given in the form of a proverb *plus* an account of a particular event, the identical relation between the two may be expressed by (a) reduction to an analogical relation and (b) making one psychological product stand for the two members. This single product came from (kinesthetic or visual) imagining or as an explanatory statement which gave the significance of both members.

(5) There is no evidence that an analogical relation between two members can be grasped merely by marking a relation between its terms. Although such a relation was noted by *O*s in unsuccessful attempts to connect the members.

Set II. The Cartoon and the Drawing

Besides appearing in literary form, analogies frequently find pictorial expression. In the second part of our research pictures were exhibited in an order similar to that in which verbal analogies were used in what precedes. Cartoons (graphic representations of one member of an analogy) composed one series. The first cartoons concerned a subject with which *O* was fairly unfamiliar, while the later members of the series pictured events of current interest.[29] In a subsequent series each item contained all four terms of an analogy, as in Series 3 above.

Series 4. Twenty political cartoons which depict figures and objects in situations suggesting the policy of a person or governing body in regard to some act of legislation, diplomacy, or judicial affair, ten concerning Czar Nicholas and his position in Russia before 1905 and ten from current newspapers. By using cartoons on a subject which *O* did not discuss in daily conversation and which portrayed situations with which he was partially if not wholly unfamiliar, we reckoned that the process of discovering significance might be prolonged. The purpose was, as with the unfamiliar verbal material, to give *O* an occasion to report as fully as possible his procedure. Intimate acquaintance with current events might shorten the performance to a point where it could not be described in detail.

These analogies are somewhat different from either of the verbal forms given. In the pictorial cartoons there are two changes. First there may be *more than two terms* related in one member of the analogy and, secondly, many of the labels on the

[29] This arrangement was not exactly comparable to the proverbs. *O* had encountered the *very same* proverbial sentences in previous experience and so had had occasion to be familiar not only with the significance to which they pointed but also with that very manner of referring to it. In the case of the cartoons he was familiar with the events they depicted, *not* with the cartoon itself. Hence all the cartoons were actually in a class with the strange proverbs.

perceived objects designate their corresponding topic or object in the other member. In one of our cartoons is a picture of an unkempt man breathing flames which raise a balloon to which a man is fastened by his neck. This picture contains several relations: the man produces the flames; the flames elevate the balloon; the balloon hangs the other man. That is actually all that the picture depicts, but the various things in it are so labelled that they point to the death of the Czar through the revolution of the common people. The cartoon indicates that the revolution affected the nobility so that anyone involved with it must have perished. Schematically the relation may be represented thus:

Picture		Russian history
man : flame : balloon : other man	::	common people : revolution : crown : Czar

This analysis may seem highly artificial to the observer of the picture, for the analogy is greatly compressed and condensed by the fact that the flame is labeled 'revolution,' the balloon is in the shape of a crown, and the man hanging from it has the features of Nicholas. That is, the beholder has no occasion to consider the balloon and the crown or the flame and the revolution as separate terms belonging to different members of an analogy.

The connection between many of the objects in the drawing with corresponding topics in history is already made; the beholder's chief task is to understand the *relations*. He has also to find the significance of some of the objects (not all are labeled, the man breathing the flames is not). The discovery of these cues, verbal and otherwise, sets a new task for *O* and affords an opportunity to study the operation of symbolizing as *O* goes beyond the perceived pictorial object, which he will have to do to reach the significance of the cartoon. We shall study (1) the course of the performance and (2) compare it with the consideration of our verbal analogies, the proverbs.

The Russian cartoons were in a book which was handed to *O* under a cardboard shield to cover everything except the picture and as much of the title as we wished to expose.[20] The cartoons of modern events were exhibited on a cardboard rack as the proverbs had been. These instructions were read at the beginning of the series:

You will be shown some pictures. Tap when you have considered them sufficiently, then report your procedure in terms of function and product.

The time from exposure to *O*'s tap was again measured in seconds.

Results. The cartoons from current newspapers depicted familiar situations which *O*s considered, on the average, only half as long as the Russian items. The great number of labels in the former reduced the opportunities to study symbolizing and also demanded less inspecting for *O* to discover significance. The performance did not differ in any essential way in the two sets. Examples drawn from the newspaper cartoons may therefore be taken as representative of both.

(1) The course of performance was, in general, the same for all *O*s. Only once was the picture named as a cartoon, an object characterized as

[20] The titles were in French and German, languages with which all *O*s were familiar.

pointing to something beyond the depicted figures ["comp (a cartoon: a picture which portrays more than meets the eye in the mere drawings and titles)" *Lo-4*-17]. In other cases the experimental situation and the instructions initiated inspection of the picture. The products were at first perceptive and inspective.

There are marked differences between grasping these analogies and dealing with the proverbs. First the labeled emphasis on specific objects causes a shift in the course of performance. *O* is occupied with finding what each item in the picture stands for before he looks for the significance of the whole picture, with each object in its proper relation. To be sure, he may not be able to discover what the separate things designate until he has at least an intimation of the signification of the picture at large, but, as reports show, the first part of the consideration is mainly a perceptive inspection of details.

What clues are there to indicate the significance of these various items?

In the first place, apprehension of the objects does not result in the product of a static picture, for *O* takes the scenes as moments in a course of events.

Comp (the Czar is coming down and is going to have his head cut off) *Mc-4*-5

Comp (the people are freeing themselves from the Romanofs. They have unloosed a bear which may get out of hand) *Lo-4*-2

Not only cartoons but 'action' pictures generally involve an apprehension of the scene portrayed as a phase of an event. There is also a temporal extension to immediately preceding and succeeding phases of the occurrence.[21] The cartoons were taken as snapshots of events *going on* and they tuned *O* to look for indication of past and future happenings.

In the first cartoon *Mc* apprehends what is going to occur and so assumes (after the report above) that the Czar "is throwing money to pacify the people." The perception of the situation as one which is going to result in disaster for the Czar led *Mc* to interpret "Duma" (the label on the object being thrown from the balloon) as some sort of bribe. Actually, of course, the Duma did serve as that, so the reported significance is not far wrong, even though the Duma was not taken as a governing body. This signification is a product of *symbolizing*. The apprehended object, with its context in the picture, gives *O* a hint that it is important in the course of events. He concludes that it is something to appease the people and names it as 'money,' one of the many things which might serve as a pacifier. For *Mc* Duma had no conventional significance, but from the context in which it appeared he guessed its function.

Again, many of the objects in the picture are marked with a word to indicate what they stand for and many without labels have conventional signification. Are these objects symbols? We have distinguished symbols from labels of a comprehended topic by the criterion that the latter derive their significance from common use and consistently point toward a certain topic. The persons or things tagged with written names, then, are not symbols, for their importance in the picture is determined by

[21] *Cf.* Bentley, *New Field*, 32-34, 52 ff., 321 ff.

O's knowledge of their labels; they are comprehended immediately, as were the familiar proverbs of Series 2. There is no transition from apprehended object to remote significance which characterizes the process of true symbolizing.[32]

In these cartoons there are such conventional 'symbols' as the serpent, the Russian bear, and the crown. In some cases they were recognized at once by *O*s as traditional representatives of evil, the Russian people, and nobility. In such events we should say that they led only to the *comprehension* of a topic which the cartoonist wished to suggest.[33]

The third clue to indicate significance is found in *O*'s attempts to 'explain' the cartoon. Objects ordinarily apprehended took on an intimation of wider signification. As inspecting of the picture continued it acquired the characteristics of the performance which Neff has called 'orienting comprehension.' "Its function appears to be to prepare the observer for later apprehension" and objects were apprehended "as test-cases used by *O* to support or weaken a projected hypothesis as to the nature of the presented material."[34]

This operation fits also into our description of the course of symbolizing. It is a good account of the last step in symbolizing, after the apprehended object has resulted in an intimation of wider significance when *O* casts about to produce the signification. He does test various possibilities of 'explanation,' eliminating some and confirming others.

Per (fat man with thin man looking at him) > com ("I suppose he would like to be able to wear that suit"). [This carried the whole idea that the Czar was thin, frightened and unhappy. The fatness stood for all the desirable things which he didn't have]; per (man in picture holding his head in his hand; words Louis XVI on his coat) > com ("oh, I see now. The Czar's afraid the same thing's going to happen to him"). [The thing took an entirely different meaning. What the Czar was looking at changed from something he wanted to something which he did not.] *Sh-4-4*

Per (lights and shadows); OI from previous picture (look for something which has to do with the Czar) > insp (face of bearded man) > comp (this is the Czar) > SI (look for evidence; maybe this is not the Czar) > insp (crown): per + comp (title "Le reveil de la liberté en Russie); per (large animal) > per (liberty; revolution) > SI (does this refer to the big revolution or some other?) > insp (flag with words "à bas la guerre") *cum* comp (this is the world war. The picture is a version of the revolution at that time); per (faces of people; drawing of animal) > per (Russian bear; Russian people). [These words seemed to sum up the representation. It seemed fitting that the bear should stand for the people although I am not familiar with it as having any conventional significance.] *Ry-4-2*

Per (picture) > com ("what does that mean?") > per (title) > comp + com ("yes, the vision of the Czar") > comp (it simply means he's represented as being a big fat person who's going to have his head cut off. This is his own future standing before him) > com ("is that a door or a mirror in front of him? I wonder if this is not the Czar himself but someone before his time who is a symbol of what's going to happen to him") *Mc-4-4*

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[32] It is assumed, of course, that the words *are* known. In the example given above it was shown that a word may take on *symbolic* significance from its context if it has none of its own.

[33] In other cases *O* had had no previous encounter with the 'symbolic' objects. They took their place, then, with other items in the picture which *signify* for the *O* what they do not *depict*. That is, they were truly symbols which occasioned the production of something utterly remote from the apprehended objects. They have the same status as objects described in our third classification.

[34] Neff, *op. cit.*, 33-35.

Pin ("look, Mme. Europe. See our new and beautiful constitution.") > OI (observe Mme. Europe) > insp [what she was looking at] (a screen between her and what was really going on. It divided the picture into two parts which were diametrically opposed) > insp (details) > comp (this is what it is actually like); com ("the cartoonist probably made Mme. Europe look so stupid to express his opinion that she didn't believe in the new Constitution"): insp (details) > S (significance of other figures on the screen). [Productless] *Lo-4-6*

Note that *Sb* supposes that the Czar is looking at something he would like to have. Inspection reveals indicators which support her assumption until she reads the label on the figure, then her interpretation of the picture is changed. *Ry* similarly orients himself in regard to the particular revolution referred to and works out a significance for the bear. [An example of a conventional 'symbol' which *O* was unfamiliar with.] *Mc*, even without reading the label on the figure of Louis XVI, postulates what the figure stands for. *Lo* inspects and orients parts of the picture to conclude that Mme. Europe's stupidity stands for the artist's conviction of Europe's skepticism toward the Russian constitution.

All these reports demonstrate, as we believe, the process of symbolizing rather than comprehending. For example, the bear is for *Ry* an apprehended object which is taken to pertain to more than a feral creature but to what 'more' he does not know. The very fact that he arrived at the conventional significance of the bear as he did shows clearly the difference between his operation and that of comprehending. Note that he does not report comprehending but only an automatic verbalization of 'Russian bear' and 'Russian people' after his perception of the bear (a drawing). "These words," he says, "seemed to sum up the representation. It seemed fitting that the bear should stand for the people. . . ." His lack of positive assertion and his reliance upon his own experience from considering the picture differentiate his procedure from that of comprehending a label for a stabilized topic. Likewise do the other *O*s produce symbolized issues which they report with varying degrees of assurance that they indicate the 'right' signification.

Note that symbolized objects are of two types; first, objects which point to a topic by standing as one member of a class. Proverbs express this kind of designation by naming a single person or object, which we take to be typical of a group (*e.g.* he who hesitates is lost; 'he' is one of the whole class of all those who hesitate). In these cartoons there are many such typical objects or persons:

Com ("it seems that the cartoon means that the people are freeing themselves from the Romanofs . . . represented by Nicholas in this case. . . .") *Lo-3-2*

Per (the big peasant represented the people . . .) *Sb-3-8*

Per (group of people representing lobbyists) *Ry-3-20*

Com ("this is a symbolic thing. The Czar is not an individual but represents a whole system") *Mc-3-1*

We should call these objects truly symbolic because a Czar or a peasant does not,

by definition, stand for a class. The pictured context and *O*'s search for significance lead to the class reference.

A second kind of symbolic object is actually depictive of no one member or part of what it represents. It gains its significance from its position in the comprehended whole, and, if encountered in isolation, would be devoid of meaning.

Per (fat man with thin man looking at him) . . . [The 'fatness' stood for all the desirable things which he didn't have.] *Sh-3-4*

Com ("Russian bear, Russian people"). [It seemed fitting that the bear should stand for the people though I am not familiar with any conventional significance of the bear.] *Ry-3-2*

Comp (I get it. The balloon represents the aristocracy trying to take him away. It is patched and in pieces.) *Mc-3-3*

Per (a rope attached to a crown which represents the monarchy) *Lo-3-3*

This kind of symbolizing is the same as that discovered in the unfamiliar proverbs, where a word in the context signified a product which it would not signify in isolation (*e.g.* "a hook's well lost to catch a salmon"; salmon does not ordinarily indicate any-desirable-thing-of-great-worth as it does in this case).

A link between perceived and symbolized objects was discovered in this series; *i.e.* ambiguous words which have both a literal and a figurative significance. For example, an adjective with dual signification may be attributed to a perceived object and then, as its second signification appears, *O* recognizes the symbolic value of the object. Witness:

Insp (second part of the printing) > comp (it's the other thing I want. It's the crown that weighs so much.) > OI (find out if this fits) > comp (but crown represents a more weighty factor in the oppression of the Russian people than the Duma which he tossed overboard, so the peasant is crying out for the crown) *Lo-3-5*

OI (formulate the significance) > comp (the king stepped on his guard too many times and now they're beginning to jab him) > com ("the King's guards are . . . "). [Couldn't get words to express it. "Get back at him," "be restless," and others came but were rejected. There was comp (significance) but I couldn't formulate it.] *Sh-3-10*

Comp (the whole thing) *cum* com ("Nicholas is standing on the thin edge of nothing. He can't keep on with his absolutism; he can't even stand just where he is because he'll fall off eventually into the boiling cauldron of the Revolution; the only way he can be saved is by Constitutional changes which will give the people more freedom. The point of the whole thing is: will the rope be long enough and will it get to him in time?"). [And of course it didn't.] *Mc-3-9*

In the last two reports *O* is reading off what the drawing depicts; nevertheless, if verbal depiction were read to someone who had never seen the picture it might have significance. These reports illustrate clearly the depictive nature of our language even when we are describing such abstract topics as government. The writer who relates topics to specific situations in this way is forceful and vivid and he may earn for himself the title of 'genius.' Such a description is a condensed form of analogy in which the two members are not distinctly separated from each other.

Conclusions. (1) The course of performance was fairly consistent with all *O*s. Titles and objects were inspected, the significance of each sought, then the significance of the picture as a whole was made an end of search. This differed from the considerations of the verbal analogies, which were rarely begun with an investigation of separate terms.

(2) The operation of symbolizing often appeared in the reports. An apprehended object was taken as a sign for a wide significance and this

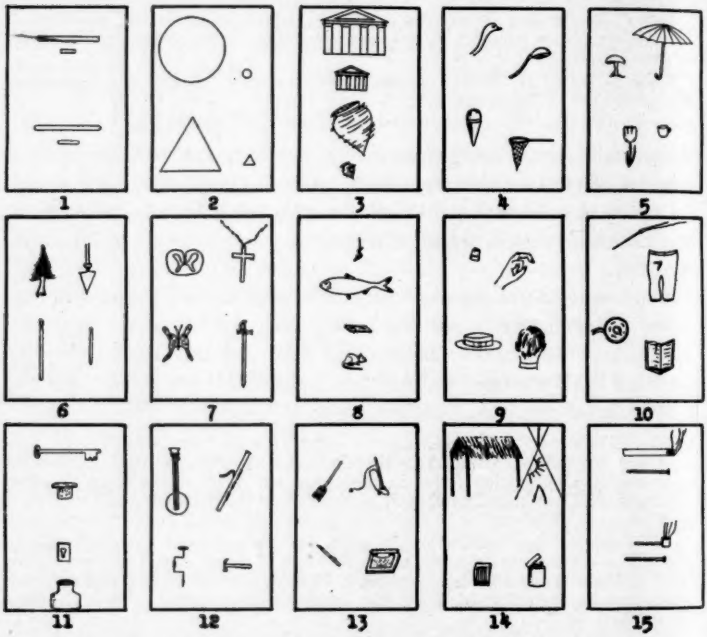

FIG. 1. MATERIALS USED IN SERIES 5

significance was described in an assumption of the artist's 'meaning' which was built up from a consideration of many of the items in the picture; or it appeared as automatic verbalization which suddenly 'occurred' to *O* and left him unable to describe any antecedents.

(3) Two kinds of symbolic objects were distinguished. The one was a generalized member-of-a-class, which was taken to stand for the entire class: the other was an object (or attribute of an object) which signified something wholly different from the object.

(4) No cartoons were reported as members of analogies. Once *O* had discovered the significance of the details of the picture, he seemed to regard the cartoon as depictive of certain relations which were not considered separately from the picture. This compression, as it were, of the two members into one product of relation is due in great part to the picturesque quality of our language, which tunes us to personify inanimate objects and to speak in metaphors by which we actually identify wholly different things and make no effort to preserve their distinctness.

Series 5. An opportunity was created for *O* to grasp relations varying in kind and form. The terms in this series were simple drawings so placed on cards that related pairs were in divers positions. The members contained objects which were similar in shape, function, relative size, or, in some cases, in two or more attributes. *O*s also found relations other than those which *E* had attempted to depict.

By this series an endeavor was made to discover (1) whether various relations between the objects were grasped in the same way, (2) whether relative position of the objects affected performance, and (3) whether sequential order in the series affected performance.

On each of the 15 cards four geometrical forms or objects were drawn. On some cards the objects were arranged from top to bottom (upper and lower pairs being related). For variation, the first and third, or the second and fourth, objects exhibited similarities. Again, an object was drawn in each quarter of the card and pairs to be related were placed either horizontally or vertically (Fig. 1).

The cards were exposed on a gray rack in the same manner as before. *O* was instructed as follows:

Consider the material to be presented and tap when you are ready to report.

The procedure and reports are divided into parts *a* and *b*. In *a*, the cards were arranged in order from simplest to most complex (1-15). The geometrical figures, which were similar in shape and proportion and drawn with related pairs together, came first. The series closed with objects related in function. They were so placed that terms of one member alternated with terms of the other member. In *b*, the same cards were again exhibited under the same conditions except that the order was altered, there being no attempt to make a gradation from simple to complex.[35] By destroying the progression through a group of first one kind then another of the relations, it was anticipated that *O* might not be set to look for one paricular relation and would now inspect cards with the task to find any connections he could.

Results. (1) The similarities which *E* had attempted to portray in the pictures were almost immediately apparent to *O*. One of the chief difficulties presented by the series was *O*'s unwillingness to dismiss the items after a brief report of likeness in shape, function, or proportion. All inspected for some other significance in the figures.

[35] Cards numbered by their place in *a* were displayed in *b* in the following order; 15, 12, 9, 6, 3, 14, 11, 8, 5, 2, 13, 10, 7, 4, 1.

Insp *cum* com ("I wonder what this is supposed to represent . . . ? Maybe this is an illusion") *Mc-5a*-1

Insp *cum* com ("It doesn't look like much of anything") > per (long thin object looks like a baseball bat) *Lo-5a*-1

Insp *cum* SI (It's probably something symbolic. Other things have been) > S > com ("the lower things look like cheese sticks") *Sh-5a*-1

Insp *cum* com ("This is very brief and simple. There should be something more to do") *Ry-5a*-2

After several items of the series had been shown, *O* finally found it sufficient to report only the relations which were apparent and to look for nothing beyond.[36]

As might be expected, the products were almost entirely perceptive where items were similar only in shape.

Pin (two similar arrangements) *Ry-5a*-1

Pin (two separate patterns consisting of long and short figures) *Mc-5a*-1

Pin (two at top alike; two at bottom alike) *Sh-5a*-7

Pin (goose's head and neck; goose-neck lamp) > com ("both objects have a slender graceful curve") > per (ice cream cone and butterfly net. Both conical in shape, the open end to be filled with something) *Lo-5a*-4

Note on *comment*. The similarity of lamp and goose is reported by comment and not directly as a product of perceiving. It has been mentioned earlier that comment stands closely related to inspecting and comprehending; we have urged that it also serves to describe products of apprehending and suggests to the person addressed further perceiving. This seems to be the case in the given example. What is the difference between naming the goose-head and the lamp and naming the 'slender curves?' Why should one be set apart as a comment and the other used to describe perceiving? Since no function other than perceiving is reported, the similarity of curves seems to be a product of that function and appears, as do the names, merely as verbal designations for the perceived objects. *Ry* describes his difficulty in distinguishing products of apprehension from descriptive verbalization:

? (figures in other items were fairly homogeneous and these were unrelated). [This function, whatever it is, is mainly apprehensive but there is also non-verbal comment on what is apprehended. I can't tell whether this is part of the apprehensive product or not.] *Ry-5a*-3

Other reports were made of words following perceiving. The words appeared as a description of the perceived relation.

Per (worm; fish; trap; mouse) > com ("worm to catch the fish; trap to catch the mouse") *Sh-5a*-8

Per (thimble; finger; hat; head) > com ("thimble for the finger and hat for the head") *Sh-5a*-9

Per (banjo; oboe; drill; hammer) > com ("there's a relationship there all right between the top two and between the bottom two") *Mc-5a*-12

Per (generalized object, a musical instrument; banjo) > com ("these are musical instruments") *Ry-5a*-12.

Per (skeleton of house with thatched roof; wigwam; dwellings) *Lo-5a*-14

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[36] *Ry* alone made this task specific; SI (it doesn't matter what the objects represent. The relationship is the important thing). *Ry-5a*-6

As perceiving and inspecting are closely related and verbal description or naming often accompanies both, it seems not unreasonable to extend the definition of comment to include word or gesture concerning apprehended objects. In the above examples, *O* appears to read off the relations from the perceived products in the same way as (in Series 1) he read off relations from objects of imagination into which he translated the sentences.

The connection of pairs was infrequently reported thus:

Insp (hammer and drill) > com ("They're both carpenters' tools") *Mc-5a*-12

SI (make the goose have something to do with the light) > insp (upper group) > com ("similarity in shape is the only relation") *Sh-5a*-4

There is evidence from these reports that *uses* as well as *shapes* were perceived as related. The possibility of perceiving the function of an instrument was discussed earlier. Examples above and below illustrate that the use of an article may come out of inspective perceiving.

Pin (the two are instruments for sweeping) *Ry-5a*-13

Pin (two smoking devices) *Ry-5a*-15

In summary, *O* was presented with objects standing in various relations to each other. The relations were grasped by perceiving and inspecting. There was no evidence of a complete correspondence between the *kind* of relation (similar shape, function, or proportion) grasped and the *kind* of function employed to grasp it.

(2) If the diversity of relation had no effect on the procedure, what was the influence of the position of related objects? In Groups 1-5 (Fig. 1) the related objects were in the same position on the card, *i.e.* upper and lower pairs were related. In Group 6, similarity was in left or right pair as well as horizontal; in Group 7 vertical pairs were related. These changes effected a turn in *O*'s consideration of later items; they suggested to him, once he had grasped a new place-relation, the possibility of future variations of the same sort.

Ry and *Lo* apprehended the vertical relations in Group 6 and both were willing to dismiss Group 7 with the comment that the objects were in upper-lower pairs. But *Sh* and *Mc* searched in Group 7 to find horizontal relations and tried to establish some connection between the two upper and two lower objects. In so doing they sought symbolic significance for the apprehended objects.

Pin (neurological slide and cross) > com ("what's that supposed to be? No relationship as far as shape goes; is that an electrical connection for a cross on a Christmas tree?") > comp (there is a current flowing through both) . . . *Sh-5a*-7

Com ("what is the relationship between the first and second pictures—maybe it's the body and soul, the section representing the body, the cross the soul"); insp (butterfly and sword) *cum* com ("maybe that's representing peace and war"); per (vertical similarities) *cum* com ("oh, they go the other way too. The sword and cross might represent war and peace. . . . ") *Mc-5a*-7

Later *Mc* again established another symbolized relation between objects which appeared in an unfamiliar order:

Pin (cigarette; nail) > com ("I wonder if that's supposed to represent the old

saw that cigarettes are coffin nails"): per (bottom pair) > com ("that must mean that by smoking a pipe you're putting your coffin together with screws") *Mc-5a*-15

All these instances are examples of symbolizing; *O* attempted to read into the drawings a significance whereby the objects could be connected as representatives of similar topics. We might speak here of 'symbolic intimation,' which may be one variety of *flash*, confining 'comment' to products of perceiving and inspecting without such remote implications as "the sword and cross might represent war and peace."

In Series 5 were reports (as also in Series 3) of anticipation of what was to be perceived. In Series 3, when one term of the second member of the analogy was read to *O*, he anticipated the *significance* of the remainder. In Series 5, however, the *object* which stood as the fourth term of the analogy was itself sometimes *named* before it was perceived, and sometimes perceived but not recognized or named until the relation of the first two terms was grasped.

P_{1a} (lower figure) *cum* com ("what is the round thing?"): per (book with torn page) > com ("I suppose the same relationship must hold. That makes the ball a spool of tape. Yes, it is") *Mc-5a*-10

P_{1a} (key; object; keyhold; bottle) > comp (related objects here are alternated) > com ("oh, bottle stopper, that's what the second thing is") *Lo-5a*-11

. . . Per (lower left) > SI (what is this?) > com ("it looks like a towel but that wouldn't fit") > OI (look at right hand figure) > P_{1a} (a lighter) > com ("the other thing must be matches") > insp (shift in per to a book of matches) *Ry-5a*-14

P_{1a} (pants and needle; round thing and a book) . . . com ("needle and thread to mend the pants") > OI (the other will be something to mend the book). [Actually no tear had been perceived in the book but this was also anticipated] > insp (tear in book; tape) > com ("yes, tape to mend the book") *Sh-5a*-10

The unrecognized object is named after perceiving or inspecting the other terms, or else the category to which it belongs is anticipated. What are the possibilities of explaining *O*'s identification of the object before it is apprehended as more than a configuration of lines?

The occasion had, by the time the above reports were made, become an instruction to look for two pairs of related articles. It has been mentioned that, as the series progressed, *O*'s performance became stabilized and he sought only the two pairs of similarly related objects.[87] Once the relation of one pair was laid hold of, *O*'s task was nearly done; he had only to inspect the other two things present to ascertain that their relation *was* the same, then he considered his performance as satisfactorily completed.

Sh noted that needle and thread are for mending the trousers. This tunes her for what will be next perceived; thing-needing-repair and means-for-repairing. From repeated experience in the series she anticipated that, of the other objects on the page, one would need repair and the other would be a means-for-repair. The process flows into anticipative search for objects of the same category and relation.

Note that the products of anticipative search differ from the extension of perceiving into the future. For instance, one sees a man dive and anticipates that he

[87] *Ry* remarks that late in the series "the relation was taken for granted; it was assumed from previous items that there would be a relationship." *Ry-5a*-14.

will hit the water. In that case it is possible actually to imagine how he will look; one may produce imaginationally almost the exact pattern which is about to be perceived. In the results given above, however, one looks forward only to the *category* to which the object will belong. There is no object apprehended in its well-defined spatial patterns; the only imagined product is an abstract object of approximately the same size as others on the page. The functions involved in this performance may be described as (1) *searching*, a forward thrusting of the organism to a goal whose essential characteristics are known but whose exact manifestation is yet to be discovered, and (2) *imagining* an abstract object (*not* a detailed concrete thing).

The nature of the unknown objects is already suspected and *O* has but to inspect and name them to complete his self-imposed task. Recognition of the one object (book) forthwith limits the other object to a means-for-repairing-books and the pattern of the stimulus is then sufficient to change the apprehended object from 'round thing' to 'tape.'

There is nothing in this performance to suggest a 'feeling of relation,' which is "detached from one pair and transferred to another case" as Woodworth's *O*s reported. None of the *O*s in this experiment discovered anything beyond apprehended or symbolized objects belonging to the same category or acting upon one another in a certain way. The psychological product of relation was not 'transferred' from one couplet to another but was maintained *in the organism* until inspecting or perceiving indicated that the other pair was or was not related as anticipated.

The analysis just given is not completely exemplified in any single report, but is borne out by scattered excerpts from the performances.

(3) After the cards were all run through, they were exhibited again, this time in mixed order. In his first encounter with the pictures, *O* had been tuned to discover similarities of shape in the first third of the group and likenesses of function in the latter cards. Now, however, one card gave no intimation of what relations might be portrayed on the next.

The result of this change was an increase in the number and variety of relations discovered by all *O*s except *Mc*, whose reports were filled with memories of what had occurred before.

Ry's performance did not change in the second half until he reported "Sudden abstractive perceiving (all four are related) > fl (maybe I've been missing something in all of these)" *Ry-5b*-9. The cards following were then closely inspected for new relations.

[Last performance] OI (look for something more in this presentation than I'd found before—some way in which all 4 objects were similar) . . . rem (last card had similar pairs vertically as well as horizontally) > insp (one group plants, the other inanimate objects) > fl (now I'm really getting somewhere) *Ry-5b*-10
(In *a*, only cup-shaped tulip and cup had been noted)

OI (look for the same thing as I found before) > comp (figures at the right are machines and ones on left are manual implements *Ry-5b*-11
(In *a*, only instruments for writing and sweeping had been paired)

Sb's inspection of the initial item of *b* was accompanied by SI (look for any different connection). While this instruction was not repeated in the succeeding

groups, the discovery of a 'new' relation in the first apparently set her to inspect the other cards more carefully and in all but three there resulted the grasping or formulation of relations not previously noted.

Com ("anyone who smokes a pipe must be screwy; whoever smokes cigarettes must be hard as nails") *Sb-5b*-1
(In *a*, similar functions of nail and screw, pipe and cigarette and similar shape of nail and cigarette had been mentioned)
(Only similarity of pairs noted in *a*)

Comp (both the tools and instruments are in a bigger class: instruments; something to be used to produce something) *Sb-5b*-2

Com ("those on left something to eat; those on right instruments to use.") (Similarity of shape of horizontal couple desribed in *a*)

In *a*, *Sb* had reported most of the relations as products of comprehending. The possibility that they were not truly comprehended has been remarked upon. It is significant to note that, in *b*, she questions her reports of comprehending.

Per (?) (nail and screw in same class). [I'd say it was merely perceiving, *perhaps* bare comprehending. It's hard to tell about those borderline cases] *Sb-5b*-1

Com ("the first two are musical instruments"). [I don't know whether the relation I formulate verbally is what I really apprehended or not] *Sb-5b*-2

Com ("both something to put on"). [Again a borderline case. I don't know whether they were apprehended or comprehended] *Sb-5b*-3

These results point to the fact that *O* realizes that terms of an analogy may be related in several ways. In the arithmetical form of analogy, terms may be shifted to other members and yet the proportion be maintained: 3/4=6/8 or 3/6=4/8. In the same way, it may be said (and *was* so reported by *O*s) that needle-thread : torn trousers :: mending tape : torn book; or needle-thread : mending tape :: torn trousers : torn book. In the first, the relation expressed in the two members is that between instrument-for-repairing and thing-to-be-repaired; in the second, the equality of terms of the *same* category is marked.■

Conclusions. (1) Apprehending, inspecting, and symbolizing produced 'relations.' With one exception, there was no correspondence of function to the *kind* of relation with which *O* was dealing, *i.e.* perceiving might yield similar shapes or similar functions. However, only symbolizing could enable the organism to connect objects as *representatives of related topics.*

(2) Analogies consisting of four pictured objects or forms offered few occasions for symbolizing. Circumstances in which no significance is immediately grasped usually instruct *O* to search for symbolic signification; few such occasions occurred in this series.

(3) Placement of the term on the card had little effect upon *O*'s procedure after he had once experienced a change in position and was no longer set to look for objects in particular places (OI).

(4) Repeated consideration of an analogy often resulted in the discovery

■ *O*s were questioned concerning their definition of 'relation.' Reports show that they agree on the significance of the word; "similarity or belonging to the same class" (*Sb-5b*-1), "any sort of similarity (of use, shape, or construction), the general topic in which they fit" (*Ry-5b*-12), "things belonging to the same general category" (*Lo-5b*-2).

of 'new' relations. This may be due to change of occasion wrought by repetition or it may be a function of change in serial order of presentation.

Analogizing with progressive reduction of occasional instruction. Two common occasions for analogizing have now been investigated, proverbs and cartoons. Our results have answered many questions; but they have also suggested new questions, questions which demand answers before even a preliminary study of the problem can be considered complete.

One of the unexpected issues of the experiment is the relative paucity of 'figurative' significance, especially in the proverbs. To be sure, no direct instruction to search out the essence of the unfamiliar maxims was given in Series 1; nevertheless, the occasion had seemed to *E* more favorable than it proved to be. The outcome is the more striking because all *O*s recognized the proverbial forms and assumed the task of discovering signification. The fact that the proverbs were not familiar hardly seems sufficient to explain *O*'s inability to grasp remote implications.

Even the familiar proverbs were not always recognized in their usual connotation. *Ry* reported that he had always assumed that he 'understood' them, but when he tried to 'explain' them he was at a loss. When the proverbs were preceded by sentences which exemplified *E*'s interpretation of their significance, they were still not always analyzed into their potential significations.

Set III. The Reduced Occasion

In our third set of experiments a means was sought to facilitate *O*'s production of 'figurative' implication of proverbs and also of lines of poetry containing one member of an analogy. The occasion was arranged to make *O*'s task more specific. As we have seen, proverbs had often been recognized as forms which characteristically carried a 'general' connotation, but *O* had not always continued his task until connotation came. He was satisfied to stop, lacking assurance that his search would result in a satisfactory conclusion. The first aim here, then, is to familiarize *O* with a certain form in which terms are related analogically and then gradually to decrease the number of given terms until *O* can proceed from one member of a proverb or poetical line and complete (by symbolizing or other means) the analogy.

Again, a problem similar to that implied in 'intelligence tests' arose; and in order to study *O*'s procedure in completing by the 'rule of three,' certain new occasions were now especially contrived.

Series 6. Twenty cards bore verbal analogies in complete or incomplete form. The entire series showed a progression from easy to more difficult tasks. Below is the arrangement for the first three cards.

Line 1	candle
Line 2	electric light
Line 3	quill
Line 4	?
Line 5	(fountain pen, restaurant, goose, queen)

The second three cards omitted Line 5, and so on (see Appendix, below, for Series 6). In the last half of the series, Lines 2 and 3 were made up from parts of a proverb or poetic line. At first, then, *O* had three terms before him to select a fourth from a group (in Line 5); then he was called upon to supply the fourth himself, and finally to supply terms which would compose an entire member standing in analogical relation with the one grasped from the upper half.

It was anticipated that OI from the earlier items would facilitate the 'understanding' of the sentences. The spatial pattern was designed to clarify *O*'s task and to bring out more products of 'figurative' significance than the earlier methods had.

Results. *O* assumed the task of replacing the question (?) on cards 1-3 by one of the words beneath (line 5).

[Reading] (ashes are to wood as steam is to) > [reading] S (applesauce, gorge, city, water) > per ("water" is the word to fit) *Lo-6-3*

Imag (silk stocking ad). [carried relation of words at top]; OI [from arrangement similar to that in last items]. (Find something which goes inside a bedspread) > SI (find something analogous to leg) > per (bed) *cum* S (this is the right word) *Ry-6-2*

[Reading] (ashes from wood) > [reading] (steam) > com ("steam from water") > S_{IM} (line below to find "water") > per (water) *Sb-6-3*

[Reading] (fountain pen, restaurant, queen, and the other) > imag (the object named) > S_{IM} (imagined objects) > com *cum* comp (pen the only one that fits) *Mc-6-1*

O had but to discover the 'right' word in the group of four. *Ry*'s report, " . . . > comp (this is the right word)" is again a mistaken designation for a function which is not truly comprehending. No topic is referred to; only recognition of a perceived word as the one for which *O* is searching. The product is one of searching, inspecting and perceiving. *Sb*'s inspection for the fourth term was an anticipative imagining, as she predicted the very object which she was about to read.

In the cards beyond the third, there was no hint to *O* what the fourth term was to be; he had to create his own substitute for the interrogation and for Line 5. Some reports show a decided change in the procedure as *O* automatically spoke the word which would fit. The word suddenly appeared, often actually not being read by *O*, who had to check after it was written to ascertain whether it fitted.

[Reading] (coal, locomotive . . . gas, (?) > (?) (automobile). [No task preceded] *Mc-6-5*

[Reading] (miller makes flour and cobbler makes a shoe). [This came before I had noticed there were no words in Line 4. The word came quite automatically and immediately. It's hard to describe it any more fully. As soon as I saw the three words, the fourth came out almost at once] *Sb-6-4*

[Reading] (cobbler) > com ("cobbler makes shoes"). ['Shoes' was an automatic completion of the sentence] > comp (this is the right word) *Ry-6-4*

[Reading] (miller : flour : cobbler : ?) > com ("a miller grinds flour and a cobbler makes shoes"). [Must be a result of comprehending of some sort. It wasn't

elaborated, but I suppose I have to elaborate it to tell you (part of a miller's occupation is grinding flour, of a cobbler's is mending shoes)] *Lo-6-4*

This seizing upon a word to finish the analogy before an analysis of the problem or a formulation of the task to find a particular sort of object appeared in 22 reports.

The missing word was also twice supplied by the longer process of formulating and describing the relation of the top words and searching for a fourth, suitable word.

[Reading] imag (miller and flour) > SI (I must get something that is related to the cobbler as flour is related to miller) > com ("of course, that could be nothing but shoes") > fl (that's right) *Mc-6-4*

[Reading] (water and boats) > imag (all sorts of water and boats in water) > per (air, ?) > com ("oh yes, the only thing that goes with air would be airplane") > imag (airplane). [The imagined airplane just appeared.] > Com ("I see the relation: the air holds the airplane, water holds boats. Both are media for transportation") *Mc-6-5*

With some cards which bore two questions (??), missing words (Lines 3 and 4) were again uttered automatically, their pertinence being scrutinized later.

[Reading] (orchid; flower : ? : ?) > com "cauliflower; vegetable") > fl (doubt) > SI (why cauliflower?) . . . *Sh-6-8*

[Reading] (blue; yellow : ? : ?) > com ("red: green") > SI (see that you have this right) . . . *Sh-6-7*

These reports have the character of 'associational responses' in tests limited to a certain category, except that here the instruction is occasional, not formal. The rapidity with which the words are supplied indicates an elliptical functioning which is difficult to describe. The longer reports must be relied upon to suggest the sort of connection which *O* makes and even they are not illuminating. There is no search, no testing of word after word. As soon as the relation of the apprehended words is grasped, the other comes quite suddenly, either from an imagining of objects which 'belong' or else verbal labels. *O*'s resources of past inclusions are so drawn upon here that the 'stimulus-word' touches off the 'response' as immediately as the first words of a familiar poem lead into the recitation of the rest of it. *O* had undoubtedly said "blue, yellow, red, green" before, but why the words should follow so quickly is not so easily explained. The function called upon here bears a closer relation to automatized acting than to any other mode.[29]

Sometimes the relation was not so quickly matched with an analogical member. There search for suitable terms might occur, the result of an equivocal pointing of the apprehended words to several relations—no similarity or relation between the two being obvious. All *O*s found on Card 9 such an ambiguity and gave several tentative 'solutions' to the task set.

[Reading] (hard and soft). [This was repeated several times and set the task to find another pair] > com ("hard steel; soft wool") > rem (diamond) > comp (valuable) > SI (If you could get another pair according to the value) > S . . . *Ry-6-9*

[Reading] com ("wedding anniversaries") > S (name of year of cotton anniver-

[29] *Bentley, op. cit.*, 217 ff.

sary) . . . (hard; soft) > S (name of something that is hard and something soft) . . . *Sb-6-9*

[Reading] com ("diamond is decayed vegetation; cotton is vegetation before it decays") > com ("what is the relation?") > imag (both are white; diamond hard and cotton soft) *Lo-6-9*

In these cases *O* investigates the subjects of diamonds and cotton. He considers not only such perceptible attributes as tactual quality and color but also topics of value and origin. 'Diamond' or 'cotton' is taken not as a generalized object of perception but representatively and topically.

The device of presenting these incomplete analogies before presenting more proverbs in the same form served to prime all *Os* (save *Mc*) to grasp their 'figurative' significance. They found the arrangement of the proverbs with the words and question-marks to be an occasion for symbolizing.

The marks of interrogation served to intimate that something was lacking and the words of the 2nd and 3rd lines stood symbolically for topics of wider signification; a function which, in the past, they had often lacked when they were encountered in the context of a sentence.

[Reading] (The wind, etc.) > comp (this means life has an inevitable effect upon all people; there are certain inevitabilities which can't be escaped, *e.g.* one grows old) > comp ('life' and 'people' may be substituted for the two question-marks) . . . *Lo-6-17*

[Reading] > comp (both parts mean the same thing: one's capacity for anything is limited no matter how much of a thing is there) > S (other words that will fit in the same way) . . . (listening to music; one concert at a time) *Sb-6-20*

[Reading] > comp (sentence) > comp (items below) > com *cum* comp (govern your time accordingly) > comp (this is analogous to the statement at the top) > SI (pick out corresponding phrases from the sentence and form a pair) . . . (govern your time according to your needs) > comp ("govern your time" and "needs" will fit) *Ry-6-13*

All these words taken from the sentence, in Line 1, have characteristics of true symbols; either they point to a variety of things which might be used to fill the interrogation or else they produce real topics for which they are not conventional labels.

Conclusions. (1) When all four terms of an analogy are perceived by *O*, the relation of the two members may be supplied perceptively.

(2) When three terms are apprehended, a name for the fourth may be automatically verbalized. A linguistic object only is perceived and reported. This performance occurred only where the analogy involved a subject wholly familiar to the observer.

(3) 'Figurative' significance of the analogical material was reported in three-fourths of the cases (9/10, if *Mc*, who was not moved by occasional instruction from the card, is omitted). Thus we may say that the primary aim of our new method was realized.

Series 7. The last series has indicated that verbal forms of analogy could be made to lead on to their 'figurative' implications by selecting from them crucial words which were so placed that *O* undertook to establish their symbolic significance.

The present series is in effect a continuation of Series 6, where poetical selections used toward the end were continued here with a further deletion of hints. The quotations themselves also seem more difficult. They were all from Tagore, characterized by Oriental mysticism which may well set them apart—when they are unfamiliar to *O*—from the Western selections.

This series offered an approach to the study of psychological operations involved in the appreciation of poetry and, more pertinent to our problem, it lent itself to a further investigation of symbolizing.

The first two cards of the series (see Appendix) bore the same formation as the last cards of Series 6; poetry in Line 1, two phrases selected from it beneath (Lines 2 and 3) and two open questions (??) at the bottom. On the next three cards the ?? were omitted, and, finally (Cards 6-20) only the poetic lines were left. The cards were exposed, as before, on a gray rack and *O* was instructed, "Tap when you have considered the material sufficiently."

Results. On the whole, the procedure of *O* was much the same as in Series 1 (unfamiliar proverbs). Again, the material was composed of statements containing one member of an analogy with which *O* was unacquainted. The change in manner of exhibiting was, of course, quite decided, since the analogies had been preceded by a method (Series 6) which gave *O* the occasional cue, and so tuned him to look for something beyond the obvious statement of the sentences.

Representative reports follow:

SI (look for something more because all the others had something beyond) *Ry-7-8*

[Words and ?'s were definite OI to look for other meanings.] *Sb-7-12*

[Most of these things are sort of proverbial in form and will apply to people. It's just habitual to translate them into human terms.] *Mc-7-19*

One marked change to be noted here (comparing with the proverbs) is the increase in reports of 'figurative' significance from 21% to 70%, probably attributable to the alteration of the form in which they are encountered (possibly also to time-order).

In the second place, the 'literal' signification has a different status in this series. In some cases it was (as before) a well-developed product of imagining or commenting before *O* proceeded to the 'figurative' significance.

. . . Comp (significance of words and the thing as a whole) > imag (bubble bursting and waves below it). [This seemed to carry a literal meaning. Beyond, the words carried a more generalized meaning. Bubble was not just a bubble but anything small and shallow . . .] *Sb-7-4*

Per (sentence) > imag (worm eating a book, peering out at a man and telling him how silly he was not to eat it; man looking horrified) > com ("I wonder what it means. I guess it's just every man to his own taste") *Mc-7-6*

[Reading *cum*] imag (tree being suddenly uprooted) . . . com ("this kind of freedom is like cutting the tree off from its source of nourishment; to make the

application in terms of mankind, it's like biting or spurning the hand that feeds you") *Lo*-7-7

. . . Imag (tree growing without any soil on a rock) > com ("emancipation from the soil is impossible") . . . imag (tall tree and a garden plant > a vague topic, rising above things; something like Freudian sublimation) > com ("millionaire") > comp (he is free from money because he has so much of it) > com ("he still has responsibilities") *Ry*-7-7

In many instances, however, the 'figurative' side of the analogy was directly arrived at without a preliminary manipulation of the 'literal' statement.

[Reading *cum*] comp (that's another way of saying "age regrets the passing of youth; age is the faded flower and spring is youth"). [The thing was there immediately without any dwelling on flowers or springs; no task or search] *Lo*-7-3

Comp (*cum* fragments of sentence). [Read, separating into phrases and pausing after each phrase] > imag (hand and pen) > comp (the topic of relativity of knowledge > topic of animal psychology). [Just came without task] > comp (the behaviorist usually reads his own perceptions of the maze into the animal) *Ry*-7-1

[Reading *cum*] comp (literal meaning; there is also another more generalized meaning) > comp (one stage departs and another stage comes on) . . . *Sb*-7-13

Notice that this performance is neither the typical procedure of Series 1 nor of Series 2. Unlike Series 1, the 'literal' significance does not stand as a well-developed product. It is reported as a transition between the words of the sentence and 'another meaning.' It is not a product of imagining or a description in comment which stands as a significance complete in itself, as did the typical 'literal meaning' of the first proverbs. Neither is there the "comp (broader meaning which we usually give it)" which often occurred as first product in Series 2 (familiar proverbs). The comprehending which accompanies the reading does not have the independence of the sentence-object in the familiar proverbs. Even though the figurative significance is quickly seized, the words of the statement still serve as intermediaries, as words which label certain concrete objects and nevertheless stand as symbolic indicators pointing to the wider connotation.

Lo unites 'flower' and 'spring' from the presented sentence with terms in her 'explanatory' statement. *Ry* takes the sentence piece by piece to arrive finally at the topic which, for him, the statement implies.

In this series, *O* is set by the occasion (as modified by preceding series) to discover a 'figurative' member, but he cannot rely—as he could in Series 2—upon former readings of the sentence to aid him in turning out this 'broader meaning.' He must turn to the sentence itself, but he is so tuned to look for more than what the separate words indicate that he does not long concern himself with their literal character. Many reports were given (see *Sb*'s report, above) of "comp (literal meaning)" which were not supported by further elaboration of what that significance was.

The words of the sentence are still important since they are the only means by which *O* can arrive at the second member, but they are now dealt with immediately as a means of transition to something beyond. The influence of the preceding series is most important in tuning *O* to look at once for 'figurative' significance, and that tuning appears as a definite and constant guide and director which is much more effective than the more or less sporadic intimations occurring with the unfamiliar proverbs.

The *final products* of the analogizing operation are the same here as in Series 1 and 2; *i.e. either* an 'explanation' in general terms, *e.g.* "comp (no class can understand why other classes do not do the thing it does)," *or* a specific example of other particular objects or persons in the same relation as those poetically indicated, *e.g.* "comp (cannibal can't see why everyone else doesn't eat men)" *Sh-7-6*

Conclusions. (1) Unfamiliar analogies are grasped with comparative ease when *O* has been definitely tuned by the occasion to discover the second (equivalent) member of the analogy.

(2) The more definitely *O* is predetermined to find the 'figurative' member in a verbal analogy the less does the perceiving of the words count in the whole psychological performance. Under the enriched occasional instruction, the words are mere signals which evoke the symbolizing transition.

General Conclusions

Our main problem has been to discover by experimental means how the organism identifies a relation in two unlike contexts, *i.e.* in 'the analogy.' Three distinct kinds of analogical formation were employed in an endeavor to search out every aspect of this process of identification.

(1) First was *the incomplete analogy.* A member consisting of two terms was exhibited, setting *O* the task of constructing a second, 'analogical' member. This formation was exemplified in proverbial and poetic statements in which the writer, instead of describing directly what he wishes to convey, creates a means for suggesting that which he intends to signify (the second member, which the reader must invent). This sort of verbal expression obviously differs from ordinary exposition, which refers to objects and topics by their conventional names and qualities; hence, in deriving significance from 'symbolic' statements, the organism presumably proceeds in a manner different from the comprehending of 'ordinary' sentences.

Results from the 'incomplete analogy' indicate, first, that to grasp the

implications of the prose or poetic proverb the hearer or reader must discover a certain relation which may be taken to hold also in events not specified in the statement. The statement is first taken as a comment on an observable event, *i.e.* the observer perceives the sentence-object (the 'literal meaning'), then he may progress to a product remote from that which is directly implied. This procedure we have called *symbolizing,* which is, in this context, a transition from the concrete and particular to the abstract and generalized. Secondly, the significance of a familiar maxim may be immediately comprehended without traffic with the sentence-object. The statement may appear at once as a label for a familiar topic. It may also, like the unfamiliar aphorism, point to remote implications.

(2) The second class of analogical formation used in the experiments was of *the four-term* variety. The four terms were so displayed as to be analogically related without reference to a wider connotation.

When results from Series 1 and 2 had revealed a relatively small number of reports of 'figurative' significance, a method was sought whereby the relation carried by the proverb might be emphasized. It seemed likely that, when *O* had clearly grasped that relation, he would then recognize the broad application of the saying. Series 3 did fulfill these expectations, for when an epigram was preceded by a sentence relating two persons or objects in the identical apposition of the terms of the proverb, *O* grasped their relation where he had previously failed. The two parts of these analogies were most often related by observation of their identical significance, *i.e.* both members were taken as pointing beyond themselves to a common product. They 'symbolized' the same thing. Thus, it appears that symbolizing is facilitated by increasing the number of symbolic products.

A series of pictures (cf. Fig. 1) in which all four terms of an analogy were present was also used to study the grasping of relations when *O* did not have the added task of creating omitted terms. Many of the similarities were noted merely through perceiving and inspecting objects of like shape, function, and relative size; some were comprehended, and symbolized products also resulted from a search to find all possible relations. Some of the objects were taken as surrogates for topics rather than as mere products of perceiving.

(3) These experiments resulted in an intermediary form of analogy, a form in which only three terms were grasped and the fourth term was a product of anticipative search or imagining. Before the proverb had been read (Series 3) or before the card had been completely inspected (Series 5) attributes of the last term were already known. Our fourth series (cartoons),

which we had intended to be comparable to the proverbs, also fell into this class. The cartoons were not isolated and distinct halves of an analogy, as the verbal members had been; for titles and many labels at once linked objects with topics of the implied analogical member. The connotation of the cartoons was discovered chiefly by inspecting details and comprehending word-labels; symbolizing came in only secondarily in the consideration of objects which were without verbal tags. Once the significance of the separate objects was discovered, the identity of depicted and implied (political) relations was complete. In fact, the two members were often not distinguished and analogizing was therefore absent.

To study the mode of completing analogies when one member and a-part-of-the-other were exhibited, a series was composed of single-word terms; four in the first items, then three, and finally two terms (Series 6). The selection of corresponding terms when four were present could be achieved through perceiving and, again, anticipative imagining of the last term before it had actually been seen. In the second case, the fourth word might come automatically or else as the result of searching after the relation of the first two words had been comprehended. The third word was then taken as suggestive of a topic and a fourth term sought from that same topic, which would stand related to three as the second term to the first.

This series was most important as an occasion for setting the task to-find-four-terms, regardless of what was given on the card. The method of gradually reducing the verbal hints (the open question to indicate that something-was-lacking and words selected from sentences to emphasize the most significant parts of the statement) proved very effective as a means for instructing *O* (Series 7), where only poetic lines were given, to continue consideration until the missing terms were turned out in their proper relation.

Results of the experiment have given no indication that there is a psychological product which may be called *a relation,* apart from terms related. There were noted sameness (of shape or of category to which various objects belonged or pointed), comparative size, difference, and the action of one thing upon another. All these were unitary products of perceiving, inspecting, comprehending and symbolizing, products which always involved objects-in-a-relation, never mere relation. Even when two analogical members of objects-in-a-relation were equated, it was never an abstracted relation which was identified; the relation was described as an apposition between general classes or orders which included the specific things named in the members.

Several problems invite further investigation. From reports on proverbs and poetry the question arises as to the functional means of 'grasping' sentences. We have suggested that sentences may be perceived and do not always call forth comprehending. A functional study of reading would be important in illuminating this point.

The pictured objects of Fig. 1 brought forth diverse reports of the psychological functioning involved. Is the *use* of such objects perceived or is it comprehended? We have brought evidence that here again perceptive apprehension may be adequate. More experimental evidence is needed.

Again, we have described symbolizing as an independent function bearing certain similarities to comprehending and to elaborative thinking. We have distinguished it from comprehending on the ground that it is a performance unlike the grasping of conventional labels and traditional topics. As the symbol produced is encountered again and again, however, it is likely to take on a stabilized significance. In the consideration of familiar proverbs we witnessed a transitional stage when *O* immediately grasped a well-known statement. In other cases, a 'literal' significance came first and then changed to the 'figurative' implication. We called this process 'symbolizing' since it was a progression from one product to another product of quite a different sort. If further investigation should reveal a closer resemblance between symbolizing and comprehending, however, it may be necessary to regard symbolizing as a specific form of comprehending. Our results in Series 1 and Series 7 now point toward the fundamental distinction which we have described.

Finally, many scattered references to values and valuing ('a clever cartoon,' 'a good epigram,' 'appreciation of the way that's stated,' and the like) suggest that an experimental study of esthetic appreciation might profitably be based on artistic material of an analogical character. Undoubtedly, the psychologist would here discover many 'value-products' tempting him to a functional analysis which would have high significance at the point where psychology meets a descriptive esthetics.

APPENDIX

Series 1. Proverbs, Strange

Visually presented

1. A drop of honey catches more flies than a hogshead of vinegar.
2. A hook's well lost to catch a salmon.
3. A colt is worth nothing unless he breaks his cord.
4. A good road and a wise traveller are two different things.
5. A little leak will sink a great ship.
6. A dwarf on a giant's shoulders sees further of the two.
7. Although it rain throw not away thy watering-pot.

8. A man cannot whistle and drink at the same time.
9. A good swordsman is not a quarreller.
10. An empty bag will not stand upright.

Auditorially presented

11. A man may love his house well and yet not ride on the ridge.
12. A mountain and a river are good neighbors.
13. A scalded cat dreads cold water.
14. A beard well lathered is half shaved.
15. A wreck on a shore is a beacon at sea.
16. Acorns were good till bread was found.
17. All are not hunters that blow the horns.
18. All keys hang on one girdle.
19. All the speed is in the spurs.
20. All your eggs have two yolks apiece, I'll warrant you.
21. Eagles catch no fleas.
22. Desperate diseases have desperate remedies.
23. Carry your knife even between the paring and the apple.
24. Be not a baker if your head be of butter.
25. A well-bred dog goes out when he sees them preparing to kick him out.

SERIES 2. PROVERBS, FAMILIAR

Auditorially presented

1. An ounce of prevention is worth a pound of cure.
2. A miss is as good as a mile.
3. Idle hands are the devil's workshop.
4. Give a fool enough rope and he will hang himself.
5. Birds of a feather flock together.
6. Little strokes fell great oaks.
7. A stitch in time saves nine.
8. All that glistens is not gold.
9. Every cloud has a silver lining.
10. You can't get blood from a turnip.
11. When in Rome do as the Romans do.
12. You can't teach an old dog new tricks.
13. Let sleeping dogs lie.
14. A rolling stone gathers no moss.
15. It's a long lane that has no turning.
16. Too many cooks spoil the broth.
17. The proof of the pudding is in the eating.
18. You can't eat your cake and have it too.
19. Little pitchers have big ears.
20. You can't see the wood for the trees.
21. You can kill two birds with one stone.
22. Still waters run deep.
23. There's many a slip 'twixt the cup and the lip.
24. No one knows where the shoe pinches but he who wears it.
25. All roads lead to Rome.

SERIES 3. PROVERBS, STRANGE, PRECEDED BY INSTANCE

(End of the instance is indicated by /)

1. They spent nearly two million dollars on advertising but as the directors said. /A hook's well lost to catch a salmon.
2. He won't ever amount to anything if he always lets his parents decide things for him. /A colt is worth nothing unless he breaks his cord.
3. "Ease and convenience are poor criteria for a good experiment," says Dr. Dall. /A good road and a wise traveler are two different things.

4. If one person ever intimated that Mr. Pratt had once been in jail he would certainly lose his office. /A little leak will sink a great ship.
5. He was a great teacher but once his young pupil Mozart had mastered the fundamentals of musical composition he was completely overshadowed by the youth. /A dwarf on a giant's shoulders sees further of the two.
6. Just after she had burned all the notes she had ever taken in French courses she was offered a position as French instructor. /Although it rain throw not away thy watering-pot.
7. Some of the lords spent many hours rebuking the queen but she remained obstinate until Lord Ashley told her he was sure that her judgment and broad-mindedness would guide her into the best course of action. /A drop of honey catches more flies than a hogshead of vinegar.
8. No one dreamed that he cared so much for the business firm he had established years before, but then /a man may love his house well and yet not ride on the ridge.
9. He is all for sober research and she likes to be with people but their marriage is successful. /A mountain and a river are good neighbors.
10. Eleanor was expelled and she left the school amid many protests of injustice but there was no more staying out past midnight after that. Verily, /a wreck on a shore is a beacon at sea.
11. He was a bright child but it was seldom that anything made him eager to study. However, when his father promised him a dog for better report cards he quickly worked up to second in his class. As his father said, /"All the speed is in the spurs."
12. The politician wants to please everyone and yet carry out his platform to the letter. However, /a man cannot whistle and drink at the same time.
13. The ignorant little heckler kept badgering him with questions but Lincoln never lost his temper nor, indeed, offered any reply to these stupidities. /A good swordsman is not a quarreller.
14. Jones tried hard as a teacher but we never learned much from him and eventually they let him go. /An empty bag will not stand upright.
15. After losing my temper and telling poor Stokes what I thought of him I found that I really liked the man but after that any friendly approach of mine was met with suspicion and doubt. /A scalded cat dreads cold water.
16. The accused man continued answering the attorney's questions, becoming more confused in his statements until he finally made his defense seem very weak indeed. /Give a fool enough rope and he will hang himself.
17. The Eleatics proved by a logical argument that motion was impossible yet every day we frequently move about. /The proof of the pudding is in the eating.
18. If the writers of our Constitution had only made slavery unlawful from the beginning think what our country might have been spared! /A stitch in time saves nine.
19. I hated the noise the Japanese made when they drank tea but when I sipped mine quietly they took offense and thought I didn't like it. I decided /when in Rome do as the Romans do.
20. She was born into a wealthy family and married a millionaire but she was to know poverty. /It's a long lane that has no turning.

SERIES 4. (A) CARTOONS OF POLITICAL SITUATIONS IN RUSSIA

(From J. Grand-Carteret, *Nicolas; Ange de la paix, etc.*, Paris)

1. *Nicolas et son peuple* (135) (N. seated on a pile of bones blowing bubbles labeled 'Duma,' 'Amnestie,' and 'Manifest'; outside the barbed wire fence which encircles the bones is a crowd of peasants with scythes and pruning hooks, shaking fists and looking angrily toward N)
2. *Le reveil de la liberté en russie* (184) An enormous bear with one paw on the cloak, the other on the shoulder of N. who is trying to slink away from the mob in the background which carries a banner bearing the legend: "Liberté. A bas la guerre").

3. *L'Assassin du Peuple Russe* (199) (N., whip in hand, hanging by the neck from a balloon-like crown which has snakes crawling from it and is supported in a flame-like gust labeled 'Revolution' which is coming from the mouth of an angry man at the bottom of the page. A silhouette of a Russian city in flames is in the background.)
4. *Le vision du Tsar* (210) (N. standing in a startled posture before a screen on which appears a figure labeled 'Louis XVI' holding his head in his hand.)
5. *Pour sauver sa tête* (212) (N. in the basket of a patched and leaky balloon throwing out a bag labeled 'Duma' to the outstretched arms of a man below. Subtitle: —"Eh! Et l'autre! Et la couronne qui tant pèse!")
6. *Potemkin II* (246) (A painted scene showing the emperor reading from a large book labeled 'Verfassung' which is held by two dignitaries of the church; people behind him are waving arms and throwing hats in air; some are pointing to a statue of a woman who is holding tablets on which is written "Pressfreiheit' and 'Redefreiheit.' This scene is placed at the top of two carpeted steps from which a woman labeled 'Europa' is looking with pleased surprise at the scene which Nicholas is pointing out to her. Behind the painting a peasant may be seen whipping a peasant, another soldier driving out two peasants before him. Subtitle: "Voyez, Madam l'Europe, notre jolie et nouvelle Constitution!")
7. *L'inendie de Moscou* (248) (N is looking with dismay at a leaking hose labeled 'Reformen' which he had turned toward the buildings of Moscow being consumed in flames labeled 'Revolution.')
8. *Dans la ménagerie russe* (255) (Four small pictures. In the first a bear is breaking through a wall, a crowned figure is climbing up the wall, a peasant is looking around the corner of it. In the second, the peasant is kicking and beating the bear while the crowned head is seen peering over the top of the wall. In the third, the peasant has the bear handcuffed and is putting a ring in its nose as the crowned figure climbs back over the wall. Lastly, the crowned figure stands arrogantly upon the chained bear draped in ermine, scepter in hand, while the peasant stands by holding the bear's chain and a whip.)
9. Title not shown (269) (An almost perpendicular face of a rocky cliff at the bottom of which flows a torrent labeled 'Revolution.' A path, 'Absolutismus,' leads to a crowned and robed figure who cannot move because the path ends abruptly and behind him the path is crumbling. Above him is a figure (lowering to him a rope which spells 'Constitution.')
10. *Le Tsar en danger* (274) (N. in nightshirt stepping upon some toy soldiers whose bayonets are thrust through his foot. Subtitle: "Oh la là! Voici que la garde d'honneur, à son tour, commence à piquer.")

Series 4. (B) Newspaper Cartoons

1. "Blustering from on high," (*Baltimore Sun*) (An old man, 'Germany,' carrying on his back large bundles labeled 'Domestic economic difficulties' and 'Monetary problem' and a cannon labeled 'Armament.' Atop the whole thing stands Hitler giving the Nazi salute, apparently in the midst of a great oratory.)
2. "East is east and west is west, but—" (*St. Louis Post-Dispatch*) (A man clad in overalls and work hat labeled 'Sitdown Strike.' Farther around the sphere on which he is sitting is a bony seated figure carrying the sign 'Gandhi.')
3. "Just when we had begun to enjoy the trip" (*Richmond Times-Dispatch*) (A stream-lined car, 'Auto Industry,' drawing the trailer 'Business Recovery' standing on 'Prosperity Highway.' Stars and clouds, 'Auto Strike,' give evidence of difficulty in the car. A man labeled 'We the People' shouts from the trailer "Hey fellers! What's the big idea?")
4. "Maybe glass isn't protection enough . . . " (*Baltimore Sun*) (An old man labeled '75th Congress' stands with hand on glass covering a plant, 'U. S. Neutrality Olive Branch Plant.' He looks anxiously at clouds and signs of confusion in the distance labelled 'European Peace.')
5. "The feature picture is about to start." (*Kansas City Star*) (On the screen of a theater is the picture of a bearded figure in chorus girl's garb beside the caption '75th Congressional Follies.' Two very large donkeys view it with satisfaction

and completely block the view of two small elephants, "The Republican Minority,' behind them, one of whom is saying "Shall we cheer when they cheer and hiss when they hiss or vice versa?')

6. "No wheels for war machines" (*Birmingham Age-Herald*) (A cannon labeled 'Europe's War Preparations' rests on the bent wheels of a 'Mark' and a 'Lira.' Beside the cannon is another broken wheel, 'European Financial Weakness.' In front of it 'European War Lords' gesture in despair and tear their hair while across the water Uncle Sam leans casually against piles of dollars labeled 'Wheels for Industry, Wheels for Agriculture, Wheels for Commerce,' and asks 'Could I interest you in a plow, mowing machine, pair o' hames or something?" In the background are the factories of 'Uncle Sam, Manufacturer of implements of peace.')
7. "Beware of hitch-hikers" (*Kansas City Star*) (A man labeled 'Strike' is trying to thumb a ride from a worker and white-collar man who are driving along in the 'Motor Car Industry.')
8. "Watch this! It's going to be a hard one!" (*Cleveland Plain Dealer*) (A donkey, Second Term and a Fat Congress, is walking the tight-rope of 'Managed Economy.' He carries, a bag in each hand; they bear the sign 'Balance the 1937 Budget Hope.')
9. "The one desirable sit-down strike" (*New York Herald-Tribune*) (Old man 'Congress' is sitting on the safe of the 'U. S. Treasury.' He says, "I've quit passing wasteful spending bills" to the lobbies who are coming to him with barrels and wagons and sack labeled 'Politics.')
10. "The real Washington egg-rollers" (*New York Herald-Tribune*) (Congressmen are rolling eggs, their 'Own pet bills' to 'Congress: Legislative Incubator.' Comments from the congressmen "The world is waiting for mine!" "The beginning of a wonderful law!" "Wait until you see this hatch!" "something worthwhile will come out of this.")

SERIES 5. (see Fig. 1)

SERIES 6. PROGRESSIVELY REDUCED OCCASIONAL INSTRUCTION

1. Candle
   electric light
   quill
   ?
   (fountain pen, restaurant goose, queen)
2. Stocking
   leg
   counterpane
   ?
   (horse, artichoke, bed, beer)
3. Ashes
   wood
   steam
   ?
   (applesauce, gorge, city, water)
4. Miller
   flour
   cobbler
   ?
5. Water
   boat
   air
   ?
6. Coal
   locomotive
   gasoline
   ?
7. Blue
   yellow
   ?
   ?
8. Orchid
   flower
   ?
   ?
9. Diamond
   cotton
   ?
   ?
10. Key
    typewriter
    ?
    ?
11. Even a hair has its shadow
    hair
    shadow
    ?
    ?
12. Dry shoes don't catch fish
    dry shoes
    fish

?
?

13. Cut your coat according to your cloth
cutting a coat
cloth
?
?

14. Do not keep a dog and bark yourself
keeping a dog
barking yourself
?
?

15. A thread will tie an honest man better than a rope
thread
rope
?
?

16. If Winter comes can Spring be far behind
Winter
Spring
?
?

17. The wind upon the field
Bows every herb and all
must yield
the wind
herbs
?
?

18. Even the weariest river
winds somewhere safe to sea
weary river
safety of the sea
?
?

19. The smitten rock that gushes, The trampled steel that springs
smitten rock trampled steel
gushing springing
?
?

20. Though one drinks at a river, one cannot drink more than one bellyful. The bird in the forest can perch but on one bough
a bellyful one bough
a river forest
?
?

[The sentences in 11-16 are taken from Benham, *op. cit.* Other quotations are from Shelley's *Ode to the West Wind* (16), Bhartrihari's *Time* (P. E. More, tr.) (17), Swinburne's *The Garden of Prosperine* (18), Dickinson's *A Wounded Deer Leaps Highest* (19), and Tso Ssu's *The Scholar in the Narrow Street* (A. Waley, tr.) (20)].

SERIES 7. PROVERBS WITH AND WITHOUT OCCASIONAL INSTRUCTION

1. To the blind pen the hand that writes is unreal, its writing unmeaning (165)
blind pen
hand that writes
?
?
2. The dew drop knows the sun only within its own tiny orb (125)
dew drop
sun
?
?
3. The faded flower sighs that the spring has vanished forever (254)
faded flower
the spring
4. In its swelling pride the bubble doubts the truth of the sea, and laughs and bursts into emptiness (139)
the bubble
the sea
5. The flower which is single reed not envy the thorns which are numerous (83)
flower
thorns
6. The worm thinks it strange and foolish that man does not eat his books (159)
7. Emancipation from the bondage of the soil is no freedom for the tree (243)
8. Its store of snow is the hill's own burden, its outpouring of streams is borne by all the world (200)

9. The butterfly has leisure to love the lotus, not the bee busily storing honey (173)
10. Flower, have pity for the worm, it is not a bee, its love is a blunder and a burden (79)
11. The judge thinks that he is just when he compares the oil of another's lamp with the light of his own (198)
12. The butterfly counts not months but moments and has time enough (15)
13. The flower sheds all its petals and finds the fruit (263)
14. They expect thanks for the banished nest because their cage is shapely and secure (56)
15. The razor-blade is proud of its keenness when it sneers at the sun (172)
16. The captive flower in the King's wreath smiles bitterly when the meadow flower envies her (199)
17. I have thanked the trees that have made my life fruitful but have failed to remember the grass that has ever kept it green (53)
18. The mountain remains unmoved at its seeming defeat by the mist (116)
19. The glow-worm while exploring the dust never knows that stars are in the sky (103)
20. The rose is a great deal more than a blushing apology for the thorn (192)
21. Clouds sorrowing in the dark forget that they themselves have hidden the sun (141)

[These selections are from R. Tagore, *Fireflies*, New York, 1931.]

RETROSPECT AND PROSPECT

By MADISON BENTLEY, Cornell University

The studies of two decades, which have been reviewed and expounded in the seven articles which precede (pp. 203-356), have been designed to give a factual account of the living organism without appeal to the category of mind and without appeal to the behavioristic principle of motor reaction upon immediate environmental cause. The first appeal would have introduced unauthentic and magical agencies; the second would have barred a direct description of the most obvious and central fact in the activities of man and other animals; the fact, namely, that the organism sees and hears objects and occurrences, cautiously inspects, understands and interprets significant situations, desires, searches out, chooses and pursues, predicts means and ends of movement, and is caught up in insoluble predicaments.

Our intent to deal factually and functionally with the organism has directed us toward a primary dependence upon the method of experiment. This method proved, however, to be inadequate to our purposes when taken in the sense common in the sciences, where more emphasis is placed upon the formal principle of 'control' and the material principle of 'mechanical conduct' than upon the exacting duties of the trained experimenter. We found the specifically trained man to be central in our method; indeed we found it necessary to divide the offices of experimenter between two scientifically trained individuals with reciprocal functions. The one function is *operational,* the other *observational,* an important corollary to observing being the technical report.[1] This reciprocal relation may be indicated in the expression, $E = (E_{oper} \times E_{obs})$.

The conditions which seemed to us to call for these refinements in procedure spring partly from the failure of the historical psychologies and partly from two devastating invasions suffered by psychology during the first quarter of this century.[2]

A brief commentary upon the last year's advancement of our program may be added.

(1) All six studies have increased our descriptive knowledge of the

* Accepted for publication February 1, 1938.

[1] See this JOURNAL, 50, 1937, 455-457, 460-461, 465-469.

[2] *Ibid.,* pp. 452-453, 462-464. Those who still use the term 'introspection' (either in a friendly or a critical way) may find it difficult at first to distinguish from the art of trained report a term and concept which the present writer would like to consider wholly obsolete.

primary functional modes and of the intimate relation between mode and product. Important functional additions have been made to remembering (Erb), inspecting and searching (all six studies), acting (Longwell, Lindner), comprehending and elaborative thinking (T. A. Ryan, Lemmon). New facts relating mode to issue are conspicuous in Werner and M. S. Ryan (the production of self-objects), in Longwell (the change of performance with practiced or 'learned' actions), and in T. A. Ryan and Lemmon (means and issues of comprehending and thinking). The new facts generally speak for the versatility and the economy of the organism, which has demonstrated its ability to reach the same or similar ends by employing various means (*e.g.* perceiving, inspecting, and comprehending; comprehending, remembering, and the repetition of verbal and actional trains).

(2) Most of the studies have tended to increase the importance of a functional group which includes searching (with and without a prophetic 'end'), inspecting, anticipating, and acting. All these functions play the changes on the *determinative* aspect of performance, an aspect which is represented in a purely physiological form by the early establishment of digestive and assimilative trains in the embryonic mammal and bird. Again, the close relationship, through determination, of acting, resolving, emoving and elaborative thinking is strongly illuminated by reference to this primordial group of functions.

(3) Another general outcome of these studies, which range over almost the entire functional series, is the fact that one single function rarely appears alone. Even in our experimental settings, where we have tried to simplify and to reduce, it is the rule (as our hundreds of technical reports will convince the reader) for the organism to combine, consolidate and interweave at any moment a plurality of functional kinds. We have here to be on our guard against oversimplification (a danger in all analysis!), and we anticipate that more composite studies (when once the modes have been sufficiently abstracted and described) will reveal a large number of performances of 'higher order.'[3] More than hints of this functional integration will be found above, especially in Longwell, T. A. Ryan and Lemmon.

(4) Many gaps remain to be filled by further research. First, our study of the main means of initiating functional operation (*i.e.* task, the three forms of instruction, flash, many automatic (bodily) devices for being specifically 'ready,' and all the available products of former functioning)

[3] The writer attempted—when descriptive materials were much more meager than they are today—this sort of composite depiction of "four typical performances of daily life;" namely, conversing, arranging, exploring and studying (*New Field*, 331-334).

have not only given us a firmer experimental control of activity, but have also directed our attention to new means of functional succession and ligation. At the same time, all these initiating means are still too conceptual and too externally related to the functional flow of daily occurrence. Much might be learned by a further comparison of them with modern works and views on 'motive' and 'motivation.'

Secondly (to dwell on more general omissions), much remains in the examination of governmental means and agents. However reluctant we may be to appeal to unconscious mechanisms, we cannot escape the influence of the biographical past in the present. Unfortunately current neurology is a poor support and endocrinology too tempting an aid. Once description arrives at the level of total-course-and-tendency, the concrete problems of guidance, government and psychological equilibration will become both pressing and promising. The physiologist's tardy grasp of the principle of homeostasis (which bears only on one aspect of governed function) should encourage the psychologist.

(5) Smaller and more precisely localized gaps in our program point toward future research in imagining, emoving, the complexer forms of action, and many sub-modes of thinking. Our recent studies now provide relatively easy formulation in all of these subjects, as well as appropriate methods. Never again should any one of these four topics be regarded as a self-contained and isolated problem. So slight is our sound knowledge of any of them that a serious and competent study could scarcely fail to relieve, or at least to reduce, the present deficiency in all psychologies. In our own laboratory, central studies of emoving and of thinking are already well advanced.

(6) The studies of T. A. Ryan and Lemmon have begun to yield ripe fruits from the early labors of plowing, planting and pruning. Intermediate stages of searching, inspecting, anticipating and acting have now thrown a bridge across from the various processes of apprehending toward the half-mythical 'higher regions.' As regards the modes which we have provisionally called comprehending and thinking, two or three of the new achievements call for comment. One of them relates to words and linguistic formations. Not quite knowing what to do with language, psychologists have comfortably looked upon words as verbal 'symbols,' 'ideas' or 'responses,' and have searched among the crevices of the brain for special housing facilities. But, omitting all reference to mind and its dwelling-places, we may now say that words are, first, *objects* in the general sense of functional products, objects which may emerge directly out of perceiving and so have nothing to do with symbols or comprehension. Words,

may, indeed, (a limiting case) be mere vocalized automatisms, bearing no direct relation to any psychological function. In the second place, words may *be* just the things which they *mean*, with no doubling of substance. Finally, words may be a species within a large genus of objects which are used, in a 'symbolizing function,' to form a transition from an object of one order to an object of a different order (as in analogizing, Lemmon, and in mathematical operations, Ryan). After turning aside from the non-psychological subject of linguistics and from logic and epistemology (the stronghold of The Understanding), we have found it possible (Neff, Ryan, Lemmon) to factor out of a gross 'comprehending' not only 'symbolizing' but several other specific modes of activity as well. Thus do we find ourselves actually in the realm of hard thinking. Here Lemmon has thrown new light on a representative form of the thought-task (the analogy) and she has shown in principle how the thinking body proceeds to collect and to use relevant materials which lead on to thought-objects or solutions. Beginning at the other end of function, Ryan has discovered an entire psychological family of thought-objects produced by the simpler mathematical operations, and he has pointed the way backward (calling upon a half-dozen of our earlier studies) toward a functional description. The obvious next step is to induce in the observer, by an appropriate occasional instruction, the creation of a specific thought-task and then to observe and record the course of solution. The great importance of this step arises from the fact that earlier students of thinking have themselves formulated the task and injected it—usually in the form of a question—into the observer. Since the creation of the thought-task is the essence of thinking, however, most previous experiments have yielded only fractional descriptions.

The direct investigation of thinking still presents many difficulties; but a new half-dozen studies, of the order of the doctoral dissertation, should put it on a firm basis and yield a major triumph for the sound method of experimentation.

The studies thus related will seem to some to be far removed from many current and popular interests of certain psychologists. While we may well agree that where these interests fall primarily within neurology, animal-training, education, sociology, business, philosophy, and the like, their relation to the program outlined will appear only as they are translated into terms and processes which have a psychological bearing. On the more positive side, however, it would be deeply regrettable if any psychologist who is responsible for order or advancement in his subject should not make capital use of every fact, principle, and method, in any context, which bears upon the psychological functions and issues of the body.

ONTOGENY OF EMBRYONIC BEHAVIOR IN AVES

XII. Stages in the Development of Physiological Activities in the Chick Embryo

By Zing Yang Kuo, Yale University

This paper proposes (1) to summarize in a convenient and readable form the mass of data concerning the physiological activities of the chick embryo which has accumulated during several years from observations on several thousand eggs, (2) to revise from new material certain statements made in previous papers of this series, and (3) to attempt a division into developmental stages of physiological activity during embryonic weeks. This division should serve as a useful reference for future experimental studies of the physiology and behavior of avian embryos at large and also for class-instruction in these subjects.

Like morphological development, the development of physiological and behavioral activities is gradual and continuous. The proposed subdivision into stages is made for the sake of convenience and exposition.

Since individual variations, both morphological and physiological, are very great during the first four days of incubation, the early age of the embryo will be designated by the number of pairs of somites rather than by the period of incubation. For normal embryos in normal position, however, extreme variations in physiological and behavioral functions are fairly rare after five days of incubation. It seems safe, therefore, to describe embryonic age after this time in terms of incubation-days. As abnormal structure and abnormal embryonic positions or abnormal environmental conditions in the egg will almost always produce abnormal behavior, our description will be confined to the normal.

A summary of morphological development in the chick. While the early morphological development of the chick has been described at length in many text-books of embryology, the following brief sketch should help the reader to appreciate the significance of the physiological activities which correspond to anatomical conditions at each stage.

(a) Development before laying. Development begins in birds before the fertilized egg is laid. Cleavage is certainly completed before laying, and gastrulation may have begun or have been already completed before incubation begins. Development is arrested after the egg is laid, but resumed soon after the egg is put into an incubator or under the hen.

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(b) The first day of incubation. This day is characterized by the formation of the following structures:

(1) the notochord, (2) the primitive streak (well developed about 16 hours of incubation), (3) formation, rapid growth and differentiation of the mesoderm, (4) formation of the head, (5) establishment of the fore-gut, (6) formation of the neural plate and its folding to form the neural groove. (The neural crests have begun to form, and the primary optic vesicle also appears), and (7) formation of a pair of primordia of the heart and formation and expansion of blood-islands.

Thus by the end of the first day of incubation many important structures have been clearly outlined. Note the early appearance of the head region, of the primordia of the central nervous system, and of the rudiments of the heart. As we shall see, cardiac action is the earliest observable or overt activity in the bird, while head-movement comes next. (This statement does not, of course, take into consideration the metabolic activities of the cells during development.) In general, four to six pairs of somites are formed during the first day.

(c) The second day. The following developmental changes are observed:

(1) head-formation is further developed, (2) closure of the neural groove to form neural tube, (3) divisions of the brain are indicated, and certain cranial and spinal ganglia are beginning to be formed, (4) about 33 hours, an auditory placode appears which in 5 or 6 hours becomes depressed to form a cavity (auditory pit), (5) extra-embryonic blood-vessels and corpuscles and intra-embryonic blood-vessels are being formed, (6) about 40 hours, the formation of the lens is indicated, (7) two cardiac primordia have been fused to form a tubular heart, (8) the primitive streak becomes shorter and shorter, finally disappearing entirely, (9) rudiments of hypophysis, thyroid, liver and respiratory system are formed, (10) fore-gut is lengthened and mid- and hind-guts are beginning to be formed, (11) new somites are added (by the end of the day, about 27 pairs), (12) flexion and torsion of the embryo have begun, (13) by about 30 hours the formation of the amnion becomes evident, and (14) formation of tail-bud is indicated.

Thus during the second day many new structures have appeared; while those formed on the first day show further development and differentiation.

(d) The third day. The following facts should be noticed:

(1) somites are increased to about 36 pairs, (2) flexure is extended to the neck region, (3) the cerebral hemispheres are strongly indicated; spinal nerves and sympathetic trunks and ganglia appear, (4) eyes and ears are further developed, (5) visceral organs are further differentiated and developed; oesophagus, stomach and duodenum are defined; the oral opening is evident, and rudiments of bile ducts, gall bladder, and pancreas appear, (6) olfactory pits have been formed, (7) limb-buds appear, (8) tail-bud has begun to curve so that its tip is gradually directed forward, (9) the amnion has completely enclosed the embryo by the end of the day and amniotic fluid has begun to accumulate in the amnion-sac, so that the embryo is bathed in a liquid medium, and (10) the allantois has appeared from the ventral wall of the hind-gut.

(e) The fourth day. The following changes are important:

(1) the size of the embryo is greatly increased, (2) torsion has been completed. The embryo has turned up to lie on its left with the entire length of the body, (3) the flexure is also completed, the body being bent into C-shape, (4) there are about 42 pairs of somites by the end of the fourth day, (5) rudiments of the tongue appear, (6) formation of rectum and cloaca from the anterior portion of the hind-gut is indicated, (7) rudiments of the permanent kidneys, the metanephros appear, (8) the limbs are further developed. They become rounded swellings, the fore limbs being relatively long and slender, the hind limbs short and thick, (9) the allantoic sac is

enlarged and projected outside the embryo, (10) the gonads are present in a rudimentary form, but no sex differentiation is apparent. (The oviducts are formed in both sexes in the form of tubal ridges), (11) the cortical substance of the adrenal bodies is also evident, and (12) other organs previously formed have undergone further development and differentiation.

(f) The fifth day. Now beak and mandible are beginning to appear. A certain cartilaginous formation is indicated. The cervical flexure is less marked. The heart has begun to retract into the thorax. The neck is indicated (practically no neck on the fourth day). The head is becoming proportionally large. The main divisions of the limbs can be detected. Previously formed structures undergo further development and differentiation.

(g) From the sixth to the tenth day. No new structures are formed during this period. The head is larger and heavier than the body. The embryo appears bird-like by the 6th day. By the 7th, it has a well-marked neck. The beak is formed. Rudiments of feathers may be seen, which become very distinct on the 9th day. On the 8th day the embryo looks decidedly bird-like; the fore limbs become wing-like, the divisions of the hind limbs are also well marked.

(h) About the thirteenth day, the nails and beak have become hard and horny.

It is clear that, in the chick, most of the organs are formed during the first two days of incubation. By the end of the 4th day, practically all structures of the body have taken shape, and many of them are fairly advanced in development. Later development is merely a process of further differentiation of the structures previously formed, of growth in size of the organs, and of changes in the general appearance of the body at large.

Physiological and Behavioral Development

Stage 1: Cardiac movements; 10-37 somites. In some cases, heart-beat begins as early as the ten-somite stage (29-30 hours of incubation). But in the majority of cases, it first appears at about the time when the embryo has 14-16 pairs of somites (about 38 hours of incubation). In the 10-somite stage, the paired cardiac primordia have just begun to be fused into a more or less straight tubular form, but there are no sharp subdivisions of the heart.

At the beginning, heart-beats are merely irregular twitchings in the cardiac walls, and there is no actual circulation of blood as the vitelline circulatory circuit has not been completed and the intra-embryonic vessels are still more or less empty. But after about 40 hours of incubation (ca. 18 somites), regular pulsations are established and circulation of blood-corpuscles is first observed.

Coincidently with the establishment of pulsation the cephalic region of the embryo begins to acquire a cranial flexure which bends the head toward the cardiac region. As a result, the head is so agitated by the beating of the heart that it nods rhythmically in accordance with the pulsation-rate. As

incubation goes on, the cranial flexure becomes more and more pronounced and pulsation becomes more and more powerful; head-noddings also increase in magnitude.[1] Heart-pulsations and, later, the circulatory movement of the large extra-embryonic blood-vessels also agitate the body of the embryo and, in fact, the whole extra-embryonic area, so that both are set into constant jerking or vibrating motions following the rhythm of the heart-beat. Such vibrating movements of the head, trunk, and extra-embryonic area are not actual physiological responses, but merely passive physical movements in response to the agitation of the heart-beat (Kuo '32 A). However, so far as the head is concerned, the passive and rhythmic movements are antecedent to the actual physiological movements of the head in the next stage (to be presently described). As a matter of fact, heart-beat has been observed to be an important stimulus for head-lifting in the second stage of physiological development in the bird-embryo. Rhythmic nodding of the head as caused by heart-beat has been observed also in several other vertebrates (cf. Tuge,[2] Windle, O'Donnell and Glasshagle[3]).

Besides these passive vibrating movements of the head and trunk, there is no active somatic movement of any sort which can be discerned during this stage of development.

Heart-rate increases as incubation goes on until the 9th day and the heart-count for each day is very highly correlated with the active movements of the embryo.[4]

Heart-beat in the chick begins when "the neural crest is yet undifferentiated, and no neuroblasts are to be found anywhere," and "the first trace of nerve cells is found in the heart of the chick about the sixth day."[5] Evidently, then, cardiac action before the 6th day must be myogenic.

Stage 2: First somatic movements; 37-40 somites. In a great many cases active physiological movements of the head appear about 37 somites; although in a few cases they may be observed as early as 36 or as late as 40 (about the 4th day). This is the first somatic movement in the chick. It is to be distinguished from the passive vibrating motions of the head which have been described in the previous stage and which continue until the fifth stage.

[1] (Kuo '32 A) Z. Y. Kuo, Ontogeny of embryonic behavior in aves: I. The chronology and general nature of the behavior of the chick embryo, *J. Exper. Zool.*, 61, 1932, 395-429.

[2] (Tuge '31) H. Tuge, Early behavior of embryos of the turtle, Terrapene carolina (L.), *Proc. Soc. Exper. Biol. & Med.*, 29, 1931, 52-53.

[3] (Windle, O'Donnell and Glasshagle '33) W. F. Windle, J. E. O'Donnell and E. E. Glasshagle, The early development of spontaneous and reflex behavior in the cat embryos and fetuses, *Physiol. Zool.*, 6, 1933, 521-541.

[4] (Kuo '33) Kuo, Ontogeny of embryonic behavior in aves: VI. Relation between heart beat and the behavior of the avian embryo, *J. Comp. Psychol.*, 16, 1933, 379-384.

[5] F. R. Lillie, *The Development of the Chick*, 1919, 472.

The earliest movement consists of head-lifting and can be observed only by the microscope. At first it appears once in a few minutes, but the frequency and magnitude gradually increase as incubation goes on. Four or five hours after the first appearance of head-lifting, head-bending may also be observed. The general nature of head-lifting and -bending has been described elsewhere (Kuo '32 A).

In this stage the cranial flexure is very pronounced and the head is bent down very near to the heart. Under such conditions not only does the cardiac motion set the head in passive rhythmic vibration; it is also quite possible that it serves as a stimulus for the active lifting of the head (Kuo '32 A, '32 C).[6]

Stage 3: First trunk-movements and response to electrical current; 90-100 hours. Trunk-movement may be observed as early as 90 hours. It consists of ventro-flexion of the trunk. During this stage, the head may nod alone, but often head-nodding is accompanied by the ventro-flexion of the trunk. The frequency of movement in this stage is about 1-3 per minute. Ventral flexion at first is limited to the anterior region, but a few hours later is extended to the posterior region of the trunk, so that when flexion occurs simultaneously in both regions the movement takes the form of a 'doubling-up' of the body. But flexion may often take place at either the anterior or posterior end of the trunk without involving the other end.

According to the earlier reports of Kuo ('32 A), Windle and Orr ('34 A)[7] the chick-embryo responses to electrical stimuli can not be elicited until 6-7 days of incubation. More recent investigations clearly demonstrate, however, that such responses can be observed as early as 90 hours and that by the end of the 5th day we should expect over 70 per-cent of embryos to be capable of responding to electric stimulation. Furthermore, excitability to such stimulation may be increased or depressed by drugs. The nature of these responses and their modification by drugs will be discussed elsewhere (Kuo '38 A, B and D).[8]

Stage 4: First limb- and tail-movements and amnion-contractions; 96-110 hours. Under ordinary conditions, limb-movements at first always ap-

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[6] (Kuo '32 C) Kuo, Ontogeny of embryonic behavior in aves: III. The structural and environmental factors in embryonic behavior, *J. Comp. Psychol.*, 13, 1932, 245-271.

[7] (Windle and Orr '34 A) W. F. Windle and D. W. Orr, The development of behavior in chick embryos: The appearance of somatic movements, *J. Comp. Neur.*, 60, 1934, 271-283.

[8] (Kuo '38 A, B and D) Kuo, Studies in the physiology of the embryonic nervous system: I. Effect of curarization on somatic movements; II. Experimental evidences on the controversy over the reflex theory in development; IV. Total pattern or local reflex? (All in press.)

pear together with head- and trunk-movements. During this stage both fore and hind limbs move sometimes passively, sometimes actively, but always with the head and the trunk. Under experimental conditions, however, independent limb-movements (*i.e.* without the participation of the head and the trunk) may be observed in this stage, in many cases at their very first occurrence. It seems incredible that Windle and Orr were unable to observe limb-movements before 7 or 8 days of incubation. I have observed literally many thousands of chick embryos, but I have not seen a single case in which spontaneous limb-movements do not occur before the first part of the 6th day.

Since Windle and Orr could study the movements of the chick embryo only after the removal of the inner shell-membrane (sometimes also of the amnion-sac), I suspect that their facts concerning the beginning of the limb- and other movements of the chick were secured under more or less abnormal conditions, in which either the chick was dying during observation as a result of injury to blood-vessels when the membranes were removed, or was lying in an abnormal position surrounded by an abnormal environment due to the removal of the membranes.

The tail almost always moves with the trunk, during this stage. But in Stage 6 it becomes capable of independent movement or moves only in conjunction with the hind-limb without participation of head or trunk.[9]

During this stage of development the following facts are of particular importance:

(1) The head and trunk are dominant in somatic movements. Other parts of the body move when the head or trunk moves. Except under experimental conditions (Kuo '38 A, B and D),[10] independent movements of parts other than the head and the trunk are never seen in this stage. However, the writer feels that he can not agree either with Coghill and Angulo or with Windle and Barcroft in the controversy over Coghill's sequence of the development of behavior. For details see the forthcoming articles (Kuo '38 A, B, D).

(2) With the exception of ocular and oral movements, which appear in Stage 6, every part of the body has displayed some sort of rudimentary somatic movement before the end of the 5th day. Movements observed in the later stages are merely transformations of early movements into other forms as a result of environmental, positional or morphological changes.

[9] (Kuo '38 C) The types of development of leg-movements from day to day during incubation will be described in detail in Kuo, Studies in the physiology of the embryonic nervous system: III. The origin and development of locomotion in the chick (in press).

[10] Cf. footnote 8.

(3) Morphological structures begin to assume physiological functions when they are in rudimentary form. The heart begins to pulsate when it is only a tubular structure. The limbs begin to move when they are merely rounded swellings. This is also true of other organs of the body. As far as the bird-embryo is concerned, few organs, if any, have not had a fairly long functional history before they obtain adult form, although the distance receptors are not sensitive to appropriate stimuli until shortly before hatching.

(4) While somatic movements in the chick begin from the cephalic region, it does not follow that development necessarily progresses caudad, as Coghill would have us believe,[11] ocular and oral movements do not appear until two or three days after movements of the limb and tail have been observed. These observations are sufficient to contradict Coghill's principle.

Amnion-contraction is observed frequently by the end of the 4th day, but in many cases it may occur as late as the 5th. In this stage the amnion-contractions are so slow and inextensive that, in some cases, they are not clearly observed without the aid of a dissecting microscope. But during the next two stages, the frequency and amplitude of these contractions are greatly increased from day to day until the end of the 8th day.

The general characteristics of amnion-contractions have been described by Kuo ('32 A) and Pierce ('33). Pierce also studied histological development of the amniotic tissues in correlation with their physiological function, as well as their responses to external stimuli. Baur ('28), Pierce and Kuo ('38 A) have investigated the effects of chemicals on amnion-contractions. Pierce found that the amnion will respond positively to such stimuli as slitting, cutting, stretching, touch, electrical current and changes in temperature. This has been confirmed by Kuo (unpublished). The work of Baur ('28), Pierce ('33) and Kuo (unpublished) has confirmed beyond doubt the conclusion of earlier workers that the amnion contains no nervous elements and therefore that its contractions are myogenic.

The effect of amnion-contraction on the behavior of the chick-embryo has been reported elsewhere (Kuo '32 C; '38 B, D). The position of the yolk in relation to the amnion likewise has an effect on the frequency and extent of amnion-contraction (Kuo '38 B, D).

Stage 5: Head-turning and lateral flexion; 5-6 days. The turning of the head to one side and lateral flexion of the trunk already present in Stage 4. But they do not come into prominence until the present stage. Head-lifting and ventro-flexion of the trunk are carried into Stage 5, but they are greatly

[11] G. E. Coghill, *Anatomy and the Problem of Behavior*, 1929. Cf. also L. Carmichael, Origin and prenatal growth of behavior, *A Handbook of Child Psychology*, 2nd ed., Clark University Press, 1933, 37-159.

reduced in frequency and magnitude in comparison with head-turning and lateral flexion of the present stage and with head-lifting and ventro-flexion of the previous stage. Ventro-flexion and the 'doubling-up' of the trunk and extensive head-lifting practically disappear by the 7th day. These changes in head- and trunk-movements have been explained by the fact that in Stages 5 and 6 the head is proportionally large and heavy and the neck relatively small and long, so that head-lifting and ventro-flexion have become extremely difficult, if not impossible (Kuo '32 C).

In lateral flexion only the upper trunk anterior to the fore-limb is at times involved. In other cases, the flexion is extended to the middle region of the trunk or as far as the tail-end. In the latter case, the flexion becomes bilateral; *i.e.* the cephalic end is bent to one side while the tail-end is bent to the opposite side. But there are also cases in which only the caudal end of the body is involved in flexion. In other words, in this stage there are three types of lateral flexion; flexion of the cephalic end, flexion of the caudal end, and compound or bilateral flexion in which both the cephalic and caudal ends are bent either simultaneously or in immediate succession to the opposite side. The third type is observed only occasionally in the early hours of Stage 5; but it increases in frequency and magnitude as incubation goes on, and by the end of the stage, and especially in Stage 6, it becomes much more frequent and prominent than the other two flexions. Its movements may be started from any region of the body (from the neck, the fore-limb, or the hind limb region). It is rather infrequent that in bilateral flexion various regions of the body involved start simultaneously. It must be recorded here that lateral flexion may also be initiated by movements of the head, limb or tail.

During this period the head and the trunk play the most conspicuous and dominant parts in movement, while the limbs and tail move sometimes passively, sometimes actively, with the trunk. Except under experimental conditions, the limb and the tail rarely, if ever, move independently (Kuo '38 A, B, D). This may be due to the fact that, since tail- and limb-movements in this stage are so inconspicuous, their occasional independent occurrence is masked or obscured by the predominant and active movements of head and trunk. However, independent head-turning without the participation of any other part of the body is frequently seen.

Whether a local movement which is initiated from the head, some part of the trunk, or the limb, will lead to massive movements depends, under normal conditions, upon the strength of the initiating movement. If the movement is strong it will eventually spread to some other part of the body; otherwise it will end as a local movement. As a general rule, the stronger

the initiating movement the wider will be the area of the body involved in subsequent movements. This is true also of later stages (Kuo '38, A, B, D).

By the end of the 5th day and especially by the 6th, bilateral flexion begins to increase in frequency, and it is often observed that such movements occur two or more times in immediate succession. This gives the suggestion that the movements are vermicular, but I cannot agree with Windle and Orr ('34 B) that such movements resemble 'swimming' and are therefore coördinated.[12] On the contrary, I would rather consider them as a series of incoördinate or diffuse movements. Indeed, if there is anything which characterizes embryonic movements, it is the very lack of coördination. (For more detailed discussion see Kuo '38 B, D.)

The vermicular movements (*i.e.* two or more bilateral flexions in immediate or rapid succession) are much more frequently observed on the 6th day—and especially during the 6th Stage—than on the 5th day.

It may be mentioned in passing that in this stage, as well as in subsequent stages, the head turns more frequently and more extensively away from than toward the yolk, with which one side of the head is in contact (Kuo '32 C).

Stage 6: Hyperactivities; 6-9 days. During this stage the heart has retreated into the thorax so that it has ceased to be a source of stimulation for somatic activities. It is the stage in which the amnion contracts most frequently and most violently. As a result, bodily movements, passive swinging, and the movements of the yolk-sac are greatly increased both in frequency and magnitude. Heart-rate too, is augmented. The curves of heart-rate, amnion-contractions, yolk-sac movements, swinging and active body movements, all run parallel and rise rapidly from the 5th to the 9th day, and then drop from the latter part of the 10th day (Kuo '32 C, '33).[13] The hyperactivity of the extra-embryonic structures and the body during this stage is unmistakable even to an untrained observer, for, under normal conditions, movements of the extra-embryonic structures and of the embryonic area are violent and almost unceasing.

In this stage the embryo lies on the yolk-sac, but not in any fixed position (Kuo '32 B), although by a special method of incubation a more favorable position may be secured so that it can be properly fixated by the end of the 10th day (Kuo '32 A, B).

[12] W. F. Windle and D. W. Orr, The development of behavior in chick embryos: Spinal cord structure correlated with early somatic motility, *J. Comp. Neur.*, 60, 1934, 287-306.

[13] (Kuo '33) Kuo, Ontogeny of embryonic behavior in aves: VI. Relation between heart-beat and the behavior of the avian embryo, *J. Comp. Psychol.*, 16, 1933, 379-384.

Movements of the eyelids usually appear on the 7th day; but there is no response to light. Movements of the eyeballs are observed one or two days later (Kuo '32 A).

Oral movements are seen in most cases on the 7th day, but in some cases on the 6th. Clapping of the beak and swallowing may occur as early as 9 days of incubation, but in the majority of cases in the next stage (10th or 11th day: compare with former statements of Kuo '32 A). These actions involving the beak and the oral cavity are not only forerunners of the future food-getting and sound-making responses of the chick but are also incorporated with movements of the trunk, especially of the thoracic region, and became constituent parts of respiratory movements (Kuo and Shen '37;[14] Windle '37).

Many of the digestive functions are originated in this stage (Kuo '32 D). Movements of the intestines and gizzard can be microscopically observed on the 8th or 9th day. And there is also some evidence that some of the endocrine organs begin to function before the end of the stage (Okuda '28; Lewis and Geiling '36).[15]

Responses to mechanical stimulation are first observed in this stage (Kuo '32 A; Windle and Orr '34). But as the methods used by these investigators are rather crude and unsystematic, further and more careful analyses seem necessary before definite conclusions can be drawn.

As a result of violent and frequent amnion-contraction, yolk-sac movement, and swinging, this period is characterized by very extensive and massive movements. To be sure, local movements of the body-parts are also observed; but, under normal conditions, massive movements are far more dominant (Kuo '32 B). These massive movements are so violent and frequent that they often overshadow the occasional local sort.

In emphasizing the massive nature of behavior during this stage, we must not, however, lose sight of the fact that certain local movements appear either with or without external stimulation (Tuge '37;[16] Kuo '38 A, B, D). In other reports we shall present evidence to show that, during this stage, environmental conditions in the egg and various conditions of external stimuli may be so controlled as to reduce massive movements to a minimum, while local movements are greatly increased. In these reports

[14] Z. Y. Kuo and T. C. Shen, Ontogeny of embryonic behavior in aves: XI. Respiration in the chick embryo, *J. Comp. Psychol.*, 24, 1937, 49-58.

[15] M. Okuda, The adrenalin content of the suprarenal capsule in the chick embryo, *Endocrin.*, 12, 1928, 342-348; M. R. Lewis and E. M. K. Geiling, Survival and increase of epinephrine in tissue cultures of adrenal gland from chick embryos, *Amer. J. Physiol.*, 113, 1935, 529-535.

[16] H. Tuge, The development of behavior in avian embryos, *J. Comp. Neur.*, 66, 1937, 157-179.

we shall point out that the total-behavior pattern and local movements belong to two distinct categories. They are the results of special environmental conditions and of the nature of stimulation. One does not necessarily antedate the other, nor is it true that one pattern is derived from the other during development. The embryonic nervous system is neutral in that it does not necessarily predetermine either type of response at any given moment of development.

In the six-day embryo, movements of the head and the trunk are most conspicuous and prominent. They take the form of head-turning-to-the-side and bilateral flexion of the trunk. However, head-lifting and ventral-flexion and the doubling-up of the trunk are still present, although they are greatly reduced in frequency and magnitude. Movements of the digits appear by the end of the 6th day. Slight digital movements may be observed by the end of the 5th day in response to electrical stimulus. Tail-movements are also active and take the form of wagging.

In the seven-day embryo, head-turning is still the most prominent movement, while tail- and leg-movements become more active and extensive than on the preceding day. On account of its length and slenderness, the neck moves only slightly and passively when the head moves. Head-lifting is very inextensive and infrequent. Bilateral flexion is reduced in frequency and extent by the end of the 7th day, while limb-movements become much more conspicuous than on the 6th day.

From the 8th day, the legs begin to assume prominence in movement. Movements of the head, trunk, and other parts of the body become much less conspicuous and less frequent than leg-movements. The neck seldom moves, and, if it moves at all, it is either passive or very slight as it accompanies head-movements. It is only in more violent movements that the neck and trunk are involved. The legs continue to be most prominent and most active in movements until 14 days of incubation (for detailed description of limb-movements from day to day see Kuo '38 C).

On the 9th day, bilateral flexion of the trunk further loses its prominence in favor of leg-movements. A new type of trunk-movement ('wriggling') appears on the 9th day and will become the major trunk-movement in the next stage, where bilateral flexion disappears.

Stage 7: Reduction of bodily activities; 10-14 days. Beginning from the 10th day, bodily activities of every sort are reduced both in frequency and magnitude from day to day. Heart-rate, too, is reduced. Hand-in-hand with the reduction of cardiac and bodily activities is the gradual decrease both in force and in number-per-minute of amnion-contractions, yolk-sac movements, and swinging, the last of which is at first reduced to slight rocking

but finally disappears entirely by the end of the 10th day. Amnion- and yolk-sac movements are seldom observed by the 14th day.

During this stage the yolk and yolk-sac come over to cover the ventral side of the body, thus normally pressing the legs to fold down against the chest. The factors which are responsible for the rise of the yolk have been described in the second paper of this series (Kuo '32 A). Such positional changes during this stage are a necessary prerequisite for the following phenomena.

(1) Without the yolk on the ventral side, bodily growth in the latter part of incubation is arrested and the embryo dies between 17 and 19 days.

(2) When the yolk-sac is not on the ventral side, it cannot be withdrawn into the body-cavity before hatching.

(3) If the legs are not properly folded down on the breast by the pressure of the yolk, they may be extended in any direction with the result that the chick, if hatched at all, will be unable to stand and to walk (for details see Kuo '38 C). Furthermore, the folding of the legs properly on the breast is itself an important factor in helping the chick to emerge from the egg, for, during hatching, it is the straightening and thrusting against the shell by the properly folded legs that breaks the shell apart (Kuo '32 B).

During this stage, massive movements are greatly reduced both in magnitude and frequency. Lateral flexion of the body practically disappears by the 10th day. Wriggling and jerking, which first appeared on the 9th day, become the sole activity of the trunk. Such changes in behavioral modes are to be explained by the fact that the embryo is so greatly increased in size as to be surrounded by a more or less congested environment, the fluid content of the egg has been greatly reduced, and the amnion and (consequently) the yolk-sac cease to contract at the end of this stage. These factors tend to make extensive trunk-movements physically impossible.

Turning of the head still remains, but it too is much less frequent and less extensive. As in the last part of Stage 6, leg-movements are still most prominent and most conspicuous.

Local movements of head and eyes, beak, and parts of the limbs are now much more obvious than in the previous stage. In fact, while total movements in the form of wriggling can be frequently observed, together with slight movements of other parts of the body, local movements are also common. This is especially true during the 13th and 14th days.

There are no striking changes in the mode of movement of eyes and beak; but due to further lengthening of the limbs and the congested conditions in the egg, the movement of the limbs are modified and reduced in extent (for detail see Kuo '32 C; '38 C).

As practically every part of the somatic structures has been functioning before this stage, there is no new kind of movement which can not be traced back to some earlier stage.

There is a gradual increase in the activity of the digestive tract (Kuo '32 D), but the details of its chemistry and neural function remain to be worked out. There is also an indication that the permanent kidneys begin to function in this period, as is indirectly proved by the sudden increase of urine in the allantois, which gives a cloudy appearance by the end of the 14th or the beginning of the 15th day. Defecation, too, first appears on the 14th or 15th day. The detail of the physiology of excretion in the chick-embryo has not yet been studied.

Stage 8: Period of relative quiet; 15-18 days. During this stage there is no striking change in morphology, except that the embryo grows rapidly in size and weight. From the 14th or 15th day the body begins to slide under the yolk, so that it gradually comes to lie lengthwise of the long axis of the egg. The head and neck, however, normally do not turn with the body (Kuo '32 B).

The behavior of the embryo is now characterized by its relative quiescence. It moves only occasionally. While there are still total, as well as local, movements, the latter are more frequent. The extent of both types is further reduced. Total movements, by this time, consist chiefly of jerking of the body and, on some occasions, of wriggling. The movements of wing and leg are also modified as a result of the more congested condition surrounding the embryo and the further drying of the liquid contents of the egg.

Even the extent of the beak-movements is reduced. The beak is now right under the yolk-sac. In the previous stage the beak could still turn rather frequently from the yolk, which was covering it; but since the body has turned to lie along-side with the egg, the turning of the beak is only seen on rare occasions (away from the yolk). Under the yolk, the beak cannot open widely, so that its movement now becomes mere clapping without a wide opening of the mouth. Clapping in this stage is generally accompanied by swallowing movements.

Environmental conditions, as well as the position of the embryo (Kuo '32 B and C), are such as to interfere not only with the lifting and bending of the head but also with its lateral turning. The only organs at this time whose movements are not greatly interfered with by the environment are the eyelids and the eyeballs. During this stage eye-movements and clapping-of-the-beak are more often observed than any other movement. In fact, while the body as a whole may be seen to be very quiet for several minutes,

eye-movements and beak-clapping are relatively frequent. Digestive functions are now advanced. As has been pointed out before, gastric and intestinal movements can be observed as early as 8 or 9 days, while kymographic tracing of such movements may be made from the 15th day (Kuo and Shen '36).[17]

While the muscles which are involved in respiratory movements have long been exercised before this stage, real respiratory movements do not take place until its end, *i.e.* two or three days before hatching (Kuo and Shen '37; Windle '37). The air sacs begin to function as reservoirs of respiratory air from the 17th day (Shen '36).[18]

My former observations seemed to show that responses to light, sound, rotation, and vibration did not appear until the next stage (Kuo '32 A). But a more recent study indicates that they can be called out even in this eighth stage. Further and better controlled experiments are necessary to decide this point.

Stage 9: Pre-hatching stage; 19-20 days. There are no essential changes in behavior from the previous stage. The bird is still quiet, but occasional wriggling is increased both in frequency and in force. Other movements remain the same. Responses to light, sound, rotation and vibration can now be easily elicited.

From the beginning of this stage the yolk begins to be drawn into the body-cavity, and at its end the yolk is completely enclosed within the body.

As part of the yolk is withdrawn, it disappears from head, neck, and a part of the thorax. As a result, the neck is protruded and lowered toward the large end of the egg, and the left side of head and neck is bent toward the breast, so that they now acquire a double bend (Kuo '32 B). This process is accomplished by wriggling movements of the body.

Meanwhile the beak pierces through the membranes and the bird begins to breathe the air contained in the air-chamber of the egg. However, respiratory movements had begun several hours before actual breathing of air (Kuo and Shen '37).[19] (Work is under way to determine whether the embryo inhales the liquid into the lungs before the membrane is pierced through.)

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[17] Z. Y. Kuo and T. C. Shen, Ontogeny of embryonic behavior in aves: X. Gastric movements of the chick embryo, *J. Comp. Psychol.*, 21, 1936, 87-93.

[18] T. C. Shen, Physiology of air sacs in birds; air sacs function as reservoir of respiratory air in chick embryos and young chicks, *Chinese J. Exper. Biol.*, 1, 1936, 105-116.

[19] Z. Y. Kuo and T. C. Shen, Ontogeny of embryonic behavior in aves: XI. Respiration in the chick embryo, *J. Comp. Psychol.*, 24, 1937, 49-58.

As a rule, peeping of the chick is heard after it begins to breath the air. But apart from occasional peeping, respiratory movements, eye-movements, bill-clapping and jerking, the embryo continues to be quiet until the next stage, the stage of hatching. As the chick occasionally lifts its beak, more membranes are gradually torn, so that it now has more space for head-movements. As a result of head-lifting the egg-shell is punctured.

All the movements described above occur only on occasion and are performed with so little force that, throughout this stage, the chick as a whole can be considered to be as quiet as in the previous stage.

Soon after pulmonary respiration is established, breathing becomes more and more regular and its rate is increased as time goes on. In the meantime, the allantoic circulation still goes on, but signs of its atrophy become very evident shortly before the beginning of this stage (Kuo '32 B; Kuo and Shen '37). And by the end of the stage, most of the allantoic blood-vessels have become disintegrated and part of the allantois is drawn, together with the yolk-sac, into the body-cavity. The liquid contents in the egg are also gradually drying up.

Stage 10: Hatching; 20th or 21st day. This stage lasts from less-than-an-hour to three-hours. As has already been stated, at its beginning the chick is relatively quiet. But in Stage 10 movements are violent and frequent, the chick breaks the egg-shell in two, and gains egress from the shell as a result of these frequent and violent movements.

As the description of the process of hatching in the second paper of this series (Kuo '32 B) now appears inadequate, and in some respects inaccurate, it may be well here to review the whole process in a more appropriate fashion.

The following conditions must be fulfilled before the hatching process can take place:

(1) Pulmonary respiration must be well-established, that the chick may have enough vigor in its struggle to get out of the shell.

(2) The remaining yolk and yolk-sac and the remnant of the allantoic sac must be enclosed in the body-cavity so that there is nothing to interfere with movement of the legs.

(3) The contents inside the shell must be completely dried and the down must not be too wet. The shell itself is by this time dry and fragile.

(4) Extra-embryonic circulation must have ceased, the blood-vessels atrophied, and the umbilical opening closed.

When the above events have been completed, the last phase of hatching begins.

As has been stated in this paper and elsewhere (Kuo '32 B), during the pre-hatching stage the neck has been protruded into the air-chamber, the head and the neck acquire a double bending with the left side resting on the breast, and (normally) the right face is tucked under the right wing. In this position, the chick, as a result of beak-thrusts, pierces through the extra-embryonic and shell-membranes. During the hours which have elapsed, the chick, which has been relatively quiet, has bored a much larger hole through the membranes and its beak thus reaches the shell. Uplifting movements of the beak result in the cracking of the shell. The size of the cracking varies roughly from 5 to 10 mm. (The chick does not peck the shell, as has been supposed by earlier writers.)

After the first cracking of the shell, the chick remains quiet for many hours (generally 5-14), and then there is a burst of vigorous activity which indicates that the hatching movements have begun. The chick now and then wriggles vigorously. Respiration becomes deep and rapid. As it wriggles, the head (which still maintains its double bending with the left face resting on the breast) lifts, and its beak cracks more of the shell. When the area of the broken shell is large enough to permit slight movements of the body, the chick begins to rotate counter-clockwise. The rotation is slow and gradual and is performed by vigorous wriggling movements, generally accompanied by lifting of the head and thrusting of the legs against the shell and often by peeping.

As the chick rotates, further cracking of the shell by beak-lifting is also counter-clockwise. When an inch or more of the circumference of the shell has been punctured, the body has been so rotated that the mid-dorsal line of lower neck and trunk is shifted from its original position to the point where the first cracking of the shell was started. The chick is now lying almost on the left side of the body. It continues to wriggle intermittently while the body is further rotated, its anterior region gradually shifting forward toward the larger end of the egg.

Due to the wriggling of the body or to the bumping of neck or head against the shell—not to the lifting of the beak, which is no longer able to reach the shell—more shell is now cracked. When a third or more of the circumference of the shell has been cracked, the rotating and forward movement of the body begins to force the large-end side of the broken shell to give way. The shell is soon separated into two parts as the body is being pushed forward and still rotated.

Now the posterior region of the body is still lying inside the other part (the small-end side) of the shell, while the anterior region has pushed

away the remainder and is lying partly on the floor. The neck by this time has begun to stretch and turn toward the left, with the result that the double bending is gradually lost and the right wing (which since the previous stage has been covering the right face of the chick) is withdrawn from the head. Finally, the neck is straightened and lies on the floor. Now and then the neck lifts or bends downward and turns with the head right or left. Meanwhile the body continues to wriggle with the thrusting of the legs against the shell. These last wriggling movements result in pushing out the entire body from the other end of the shell. Hatching is now complete.

Immediately after the chick has gained complete egress from the shell, it can neither walk nor stand. It continues to have intermittent wriggling and rotating movements, which cause it to roll on the floor. The moment it attempts to stand, the body falls. The head can be lifted only feebly and with difficulty. It generally drops immediately. Finally the body and the head-and-neck (which are stretched out) come to rest on the floor, usually with the ventral side down, but sometimes either the neck alone or neck-and-body may lie on either side. The resting chick occasionally lifts its body, either to fall again (sometimes the body rolling over) or to move forward for a short distance and then lie quietly. This is repeated every few minutes. After 1-4 hours, when the down is more or less dried, the chick is able to stand and walk, and to raise its head and neck more or less in the manner of the adult fowl.

The hatching movements are vigorous and violent. Both respiration- and pulsation-rates are increased during and shortly after hatching. The movements appear to be very fatiguing, as the chick now takes frequent and long intermissions, during which it rests almost motionless while respiration continues deep and rapid and heart-rate accelerated. Post-hatching behavior of the chick has not been systematically studied and thus no adequate data are at hand.

Summary

The development of the somatic activities of the chick-embryo, from the beginning of heart-beat to hatching, has been divided into ten stages. In each stage the chief events are described. These events are summarized in the following chart.

Ten Stages in the Embryonic Development of the Chick

Stage	Age	Morphological features	Positional changes	Activities observed	Changes and their causes	General characteristics
I	10 som.	Most organs formed; tubular heart; amnion formation.	Flexion and torsion begin.	Heart beat; passive head and body vibrations.		No somatic movement.
II	37–40 som.	Limb buds and allantois appear; amnion enclosed.	Further flexion and torsion.	Head lifting and bending.		
III	90–100 hr.		Flexion and torsion complete.	Ventro-flexion of trunk; response to electricity.		Movements of head and trunk prominent.
IV	96–110 hr.			Limb and tail movements; amnion contraction; "doubling up" of body; slight head turning.	Head lifting changed to turning due to change in proportional size of head and neck.	Same as previous stage.
V	5–6 d.	Beak and mandible appear; neck indicated; head large; limb divisions detectable; retraction of heart begins.		Head turning; lateral and bi-lateral flexion; vermicular movements.	Due to lengthening and slenderness of neck and to bulky head ventral flexion disappears.	Same as previous stage.
VI	6–9 d.	Head larger and heavier than body; embryo bird-like; limb divisions well defined; neck long and slender; feather rudiments.	No fixed position.	Movements of eyeballs, eyelids, beak and parts of limbs; swallowing; functions of digestive and endocrine organs.	Increase in length and size of body parts causes modification of modes of movements.	Hyperactive in every form; massive movement dominant; leg movements prominent by latter part of this stage.
VII	10–14 d.	Size increase; nails and beak horny; head smaller in relation to body; more feathers.	Position fixed by 10th day; yolk sac come over to cover ventral side from 11th day; legs folded on breast by 14th day.	Wriggling and jerking.	Increase in size and length of body and congestion in egg cause wriggling and jerking.	Reduction in all activities; more local movements than previous stage.
VIII	15–18 d.	Increase in size.	Body turned to lie lengthwise with long axis of egg.	Respiratory movements.		Period of quietness; more local movements than massive movements
IX	19–20 d.	Atrophy of allantois; withdrawing yolk into body cavity in progress.	Protrusion of neck into air cell, acquiring double bend.	Responses to light, sound, rotation and vibration; peeping.		Same as previous stage.
X	20 or 21 d.	Yolk withdrawal and atrophy of extra embryonic circulatory systems completed; liquids inside shell dried.				Vigorous wriggling accompanied by head lifting and leg thrusting

THE INFLUENCE OF SOCIAL FACILITATION ON MOTOR PERFORMANCE AT DIFFERENT LEVELS OF INTELLIGENCE

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The purpose of this investigation was to study the relative influence of social facilitation on simple motor performance at two different subnormal intelligence levels.

It has been attested in many experiments that social facilitation occurs when individuals work at tasks in each others presence. The problem has been studied mainly from the point of view of varying the nature of the task or the conditions under which the task is performed, alone or in a group. In tasks requiring cancellation of letters or word association, speed and errors have increased under conditions of group performance.[1] Even a visual task, which required no overt motor behavior was learned more quickly in the group situation.[2] On the other hand, Allport found that where a task required logical thinking, the quality of performance was reduced under group conditions.[3]

Problems of differential and comparative psychology have also been considered in connection with social facilitation. Allport reported that children were more susceptible to the influence of social facilitation than adults.[4] He felt the difference was due to the influence of negative suggestion among the adults. Various investigators find individual differences, particularly that slower workers are relatively more influenced than faster workers, and that more high-strung individuals are overstimulated with consequent decrease in speed in the group performance.[5] In animal studies on albino rats, no clear cut influence of social facilitation has for the most part been demonstrated.[6] In one experiment, however, some interstimulation took place in that rats ran an alley faster in pairs than alone.[7]

No specific mention has been made of the rôle played by different intelligence levels on social facilitation. Consequently, we planned to keep the task simple and constant, and vary the intelligence level in order to study this aspect of the problem.

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[1] W. Moede, *Experimentelle Massenpsychologie,* 1920, 133-136; F. H. Allport, The influence of the group upon association and thought, *J. Exper. Psychol.,* 3, 1920, 159-182; J. F. Dashiell, An experimental analysis of some group effects, *J. Abnorm. & Soc. Psychol.,* 25, 1930, 190-199.

[2] H. Gurnee, Learning in the collective situation, *Psychol. Bull.,* 33, 1936, 758.

[3] F. H. Allport, *Social Psychology,* 1924, 273-274.

[4] Allport, *op. cit.,* 278.

[5] Moede, *op. cit.,* 193-198; N. Triplett, The dynamogenic factors in pace-making and competition, this JOURNAL, 9, 1898, 507-533.

[6] R. H. Bruce, An experimental analysis of social factors affecting performance of white rats motivated by the thirst drive in a field situation, *Psychol. Bull.,* 34, 1937, 738; W. M. Lepley, The social facilitation of locomotor behaviour in the albino rat, *idem,* 739; R. H. Waters, Group and individual maze learning by the albino rat, *idem,* 739.

[7] W. M. Lepley, Competitive behaviour in the albino rat, *J. Exper. Psychol.,* 21, 1937, 194-201.

Method and Procedure

Task. For motor performance we chose a paper and pencil maze without blind alleys. The mazes were mimeographed on sheets of white paper that were fastened securely in a frame clamped to a table. We measured the effect on performance of the *Ss* tracing the maze alone or in pairs. The task was to draw a line around the pathway as fast as possible without touching the sides. The pathway was ¼ in. wide and there were 23 corners to turn. The pencil used was placed in a holder, a piece of iron tubing bound with tape, which could be grasped firmly in *S*'s hand. The pencils were always of the same length and quality and were held in an upright position at right angles to the paper. Scoring was time taken from start to finish with penalty for errors (touching the sides of the pathway), 1/5 sec. being added to the time-score for every error made. Pressure was also measured by the number of carbon impressions per trial.

Subjects. The *Ss* were of 2 subnormal intelligence levels. One group consisted of 38 girls with IQ of 50-59, the other group of 36 girls with IQ of 70-79.[8] The IQ was measured by the Otis Intermediate Self-Administering Examination. The lower and higher groups were also distinguished on the basis of non-language test performance; the low group having mental ages under 13 and the high group having mental ages over 13 on the Pintner Non-Language. The chronological age of all the *Ss* was 15 or 16. The groups were equivalent also in social and economic backgrounds.

Series 1

Procedure. The *Ss* came for 4 experimental periods and were given 20 trials per period with a rest of 3 min. between trials 10 and 11. The two groups, low and high, were further divided into 4 approximately equal subgroups on the basis of type of practice period, working alone or in pairs. Subgroup A worked alone for three periods and in pairs on Period 4. Subgroup B worked in pairs for three periods and alone on Period 4. Subgroups C and D worked alternately alone and in pairs. The plan for these practice periods is shown in Table I.

TABLE I

Plan of Practice Periods

(*a* = working alone; *t* = working in pairs)

Subgroups	Periods			
	1	2	3	4
A	*a*	*a*	*a*	*t*
B	*t*	*t*	*t*	*a*
C	*t*	*a*	*t*	*a*
D	*a*	*t*	*a*	*t*

The *Ss* always had the same partners. No *S* in the low group was ever paired with an *S* in the high group. No explanation was given as to the purpose of working alone or in pairs and no reference was made to competitive behavior. The *Ss* were merely told to see how well they could do. When working in pairs the *Ss* sat facing each other on opposite sides of the same table. The author and an assistant acted as

[8] One *S* in the low group (Subgroup A) made such poor scores that only the results of 37 *Ss* are recorded in this study.

experimenters, each one working with approximately one half of the *Ss* and always with the same *Ss*.[9]

Results. Since much learning went on during the first experimental period, these scores were not taken into account in working up the data, nor was the first of the 20 trials in each of the succeeding periods. Averages, P.E., $P.E._{diff.}$, and critical ratios were obtained for the successive experimental Periods 2, 3, and 4 for the low and high groups.

TABLE II

AVERAGE SCORES AND MEASURES OF VARIABILITY FOR LOW AND HIGH SUBGROUPS IN SERIES 1
(*a* = working alone; *t* = working together in pairs)

Group	Subgroup	No. trials per period	Periods		
			2	3	4
Low	A	209*	(*a*) 14.07±1.96	(*a*) 13.10±1.92	(*t*) 11.28±1.07
	B	190	(*t*) 12.54±1.04	(*t*) 11.08±0.85	(*a*) 10.55±0.70
	C	152	(*a*) 13.76±3.21	(*t*) 11.96±1.06	(*a*) 11.96±1.25
	D	152	(*t*) 13.26±1.11	(*a*) 12.47±1.27	(*t*) 10.02±0.79
High	A	190	(*a*) 12.27±1.59	(*a*) 11.66±1.41	(*t*) 11.11±0.91
	B	190	(*t*) 10.28±1.00	(*t*) 9.55±0.84	(*a*) 9.31±0.92
	C	152	(*a*) 12.69±1.26	(*t*) 11.10±1.02	(*a*) 10.78±0.93
	D	152	(*t*) 11.73±1.91	(*a*) 10.73±1.25	(*t*) 9.36±0.93

* See footnote 8.

(1) Our first comparison deals with the results for the low and high groups during the same experimental period. All the low and high *Ss* do consistantly better when working in pairs than when working alone (Table II). There is, however, one exception. In the final practice period, the subgroups B of both low and high *Ss* did better, even though working

TABLE III

RESULTS OF PERIOD 4

Group	Subgroup	Type of task	Diff. of av. score	$P.E._{diff.}$	Crit. ratio
Low	B	*a*	.73	.09	8.2
Low	A	*t*			
High	B	*a*	.80	.09	8.6
High	A	*t*			

alone, than Subgroups A who were now working together. Subgroups B had previously had three practice periods of social stimulation of working in pairs so that, even when finding themselves alone in the final period, they kept up their superior performance and did reliably better than the Subgroups A who had previously worked alone three times. The differ-

[9] The work was carried on in the Trade Extension Classes of the Manhattan Industrial High School for Girls, New York City, during the spring of 1937. Thanks are due Miss Jane Sill for assisting in the experiment.

ences are statistically reliable as can be seen from the results shown in Table III.

(2) Our second comparison deals with the results of successive experimental periods. We find a much greater improvement from one period to the next when the succeeding period is a period of working in pairs rather than one of working alone. That is, if we compare the averages for an *a* (alone) period or a *t* (together) period followed by a *t* period, we find much more improvement than in the cases where an *a* or a *t* period is followed by an *a* (alone) period (Table IV). These results hold

TABLE IV

DIFFERENCES BETWEEN AVERAGE SCORES AND MEASURES OF RELIABILITY OF DIFFERENCES FOR SUCCESSIVE PERIODS FOR LOW AND HIGH SUBGROUPS

Group	Sub-group	No. trials	Periods compared	Type of practice	Diff.	P.E.$_{diff.}$	Crit. ratio
Low	A	209	2, 3	*a*, *a*	.97	.190	5.09
	A	209	3, 4	*a*, *t*	1.82	.152	11.91
	B	190	2, 3	*t*, *t*	1.47	.097	15.10
	B	190	3, 4	*t*, *a*	.53	.078	6.80
	C	152	2, 3	*a*, *t*	1.80	.274	6.57
	C	152	3, 4	*t*, *a*	0	0	0
	D	152	2, 3	*t*, *a*	.79	.136	5.80
	D	152	3, 4	*a*, *t*	1.45	.121	19.66
High	A	190	2, 3	*a*, *a*	.61	.154	3.97
	A	190	3, 4	*a*, *t*	1.55	.122	12.77
	B	190	2, 3	*t*, *t*	.73	.095	7.69
	B	190	3, 4	*t*, *a*	.25	.091	2.60
	C	152	2, 3	*a*, *t*	1.59	.132	12.11
	C	152	3, 4	*t*, *a*	.32	.112	2.80
	D	152	2, 3	*t*, *a*	1.00	.140	7.14
	D	152	3, 4	*a*, *t*	1.37	.125	10.97

true for both the low and high groups, indicating that some learning does go on in successive periods but that the improvement is greatly accelerated by the condition of working in pairs.

(3) Our third comparison deals with the performance of the *Ss* of lower and higher intelligence on the same experimental periods and in the subgroups having the same type of practice (comparing high A with low A, high B with low B, etc.). We find that the high subgroups always do reliably better than the low subgroups. Not only that but when working in pairs, the high subgroups do exceptionally well. That is, they do relatively better working in pairs than when working alone, if their performance is compared with that of the low *Ss*. Table V shows the actual differences in average, P.E.$_{diff.}$, and critical ratios between the scores of the low and high Subgroups A, B, C and D when they are working alone or together in pairs. As can be seen, the critical ratios are, for the most part,

a good deal larger and more valid under the condition of working under social stimulation in pairs. There is one marked exception, that of Subgroups B on Period 4 when they are working alone. The more intelligent *Ss* do especially well in this period (crit. ratio, 14.78). Now all the *Ss* in Subgroups B had worked three times in pairs prior to this period of

TABLE V

DIFFERENCES IN AVERAGE SCORE AND MEASURES OF RELIABILITY BETWEEN LOW AND HIGH GROUPS

Type of practice: Alone					Together in pairs				
Subgroup	Period	Diff.	P.E.$_{diff.}$	Crit. ratio	Subgroup	Period	Diff.	P.E.$_{diff.}$	Crit. ratio
A	2	1.8	.178	10.12	A	4	1.17	.102	11.71
A	3	1.45	.167	8.65	B	2	2.26	.105	21.51
B	4	1.24	.084	14.78	B	3	1.53	.086	17.73
C	2	1.07	.280	3.8	C	3	0.86	.120	7.20
C	4	1.18	.126	9.3	D	2	1.53	.132	11.55
D	3	1.56	.144	10.59	D	4	1.49	.098	15.22

working alone. The result thus indicates the carry over of the greater effects of social facilitation on the part of the *Ss* with higher IQ.

Furthermore, by making cross comparisons between different subgroups, we find added evidence for the greater effect of social facilitation among the more intelligent subnormal girls. Let us compare the performance of high A, that worked alone for the first three periods, with the perform-

TABLE VI

COMPARISON OF PERFORMANCES OF THE HIGH GROUP THAT WORKED ALONE DURING THE FIRST THREE PERIODS AND THE LOW GROUP THAT WORKED TOGETHER IN PAIRS DURING THOSE PERIODS

Group	Subgroup	Period	Av. score	Diff.	P.E.$_{diff.}$	Crit. ratio
High	A (*a*)	2	12.27±1.59	.27	.138	1.99
Low	B (*t*)	2	12.54±1.04			
High	A (*a*)	3	11.66±1.41	.58	.119	4.86
Low	B (*t*)	3	11.08±0.85			
High	A (*a*)	4	10.11±0.91	.44	.084	5.19
Low	B (*t*)	4	10.55±0.70			

ance of low B, that worked together in pairs during those periods. As can be seen from Table VI, the *Ss* of group low B, do as well in Period 2, as those of high A. In Period 3, under these same conditions, low B surpasses high A with an advantage that is statistically reliable. In Period 4, where high A first works in pairs, its performance improves so much that it does reliably better than low B. It may be mentioned, in addition, that during this period the performance of low B, even though working alone, is not

worse than its performance in the preceding period, so that the superiority of high A is not due to a let down in performance of low B in Period 4, but is due to a marked improvement of the high *Ss* under social facilitation.

SERIES 2

Procedure. Two months after finishing the experiments of Series 1 we performed a second series of experiments upon the same *Ss*. Here the high and low groups were divided into only two subgroups, A and B. Subgroups A came for two periods alone and in pairs on Period 3. Subgroups B came for two periods in pairs and alone on Period 3. All the *Ss* had different types of practice periods than they had in Series 1. The *Ss* in the old Subgroups C and D were evenly distributed between the new Subgroups A and B. No *S* had the same partner as in Series 1. Otherwise, the conditions for experimenting were the same in the two series. The *Ss* were told to see how well they could do after a long rest.

Results. Many of the results of this later series confirm those of the initial series (Table VII). In the first place, when the final trial is a *t*

TABLE VII

AVERAGE SCORES AND MEASURES OF VARIABILITY FOR LOW AND HIGH GROUPS, SERIES 2

Group	Subgroup	No. trials per	Periods		
			1	2	3
Low	A	266	(*a*) 10.44±1.06	(*a*) 9.85±1.01	(*t*) 9.18±0.88
	B	266	(*t*) 10.89±1.55	(*t*) 10.62±1.41	(*a*) 10.51±1.26
High	A	247	(*a*) 9.11±0.92	(*a*) 8.74±0.83	(*t*) 8.17±0.77
	B	285	(*t*) 9.44±0.79	(*t*) 9.29±0.79	(*a*) 9.22±0.85

(together) trial, the performance is very much better than in the preceding *a* (alone) trial. If the final trial is an *a* trial, the performance is no better than in the preceding trial. This holds true for the low and high groups. Secondly, the high groups do consistantly better than the low groups when the same subgroups and periods are compared.

There is, however, one outstanding difference between Series 1 and Series 2. That is, even though the high and low subgroups B in our second series received more social stimulation than A, and improved in successive periods more than A, they have never reached the level of performance of A, as can be seen from Table VIII. The performance of Subgroups A was reliably superior to that of Subgroups B. This was true for the lower and higher intelligence levels (with the exception of Period 1 for the low group where the critical ratio is not quite 4). This means that social facilitation in a later series was not as effective as social facilitation in an initial series in bringing about the best performance of all *Ss*. The pattern of later performance is dictated by the pattern of earlier performance.

Nevertheless, the low and high Subgroups B did relatively much better in the first period of Series 2 than they had done in the fourth and last period of Series 1. This improvement was greater than that of Subgroups A. We took the average scores on Period 4 for the *Ss* in the different subgroups of Series 1, who acted as *Ss* in the Series 2, and compared these

TABLE VIII

DIFFERENCE BETWEEN THE AVERAGE SCORES OF SUBGROUPS A AND B
(Scores of A superior to B)

Group	Period	Diff.	$P.E._{diff.}$	Crit. ratio
Low	1	.44	.115	3.86
	2	.77	.106	7.26
	3	1.33	.094	14.14
High	1	.33	.077	4.33
	2	.55	.072	7.58
	3	1.05	.074	14.16

averages with those for these same *Ss* on Period 1 of Series 2 with the results shown in Table IX.

Consequently, we can say that social facilitation worked in Series 2, but not to the extent that it did in Series 1. This result is in conformity with the results of other investigators who have reported that social facilitation is less effecive as work continues.[10]

TABLE IX

COMPARISON OF *S*'s RESULTS IN SERIES 1 AND 2

Group	Subgroup		No. trials	Av. score	Av. score	Diff.	$P.E._{diff.}$	Crit. ratio
	Ser. 1	Ser. 2		Per. 4 Ser. 1	Per. 1 Ser. 2			
Low	B, C, D	A	266	10.62±1.04	10.44±1.06	.18	.091	1.90
	A, C, D	B	247	11.60±1.53	10.75±1.53	.85	.139	6.09
High	B, C, D	A	247	9.57±0.91	9.11±0.92	.46	.083	5.61
	A, C, D	B	247	10.34±1.00	9.44±0.795	.90	.078	11.57

Pressure. An attempt was also made to see whether there was a difference in the amount of pressure exerted by the *Ss* in tracing the maze under the conditions of working alone or in pairs. As we indicated earlier in describing the task, the pressure was measured by the number of carbon impressions. These measurements were made for the 1st, 10th, 11th and 20th trials during each period in both series. Eight carbons were used for every trial. Under every carbon was placed a plain sheet of paper, all of the same thickness, for recording impressions. Between the paper on which the maze was traced and the first carbon, there was a thick sheet of wrapping paper. This insured covering the carbons completely and also obviated the use of a very large number of carbons. On the trials where carbons were not employed, the

[10] N. N. Sengupta and C. P. Sinha, Mental work in isolation and in group, *Indian J. Psychol.*, 1, 1926, 106-110; Allport, *op. cit.*, 166.

papers under the maze were of the same size and thickness so that the *Ss* never knew that the conditions were different for different trials. Scoring was made by counting the number of carbon impressions, one point was given for each impression showing more than half of the maze and ½ a point was given for an impression for one half of the maze or less. The scores for trials 1 and 10 and for trials 11 and 20 were added together and these summated scores were averaged. We first found the average scores for all the trials where the *Ss* worked alone and for those where the *Ss* worked in pairs.

TABLE X

AVERAGE PRESSURE-SCORES FOR THE DIFFERENT GROUPS OF *Ss* UNDER THE DIFFERENT WORKING CONDITIONS

Series	Group	Working alone	Working together in pairs
1	Low	9.08±2.00	9.09±1.72
	High	8.89±2.17	8.40±1.81
2	Low	8.82±2.00	8.29±1.61
	High	7.39±1.91	7.51±1.99

As can be seen from Table X, social facilitation plays no part in influencing differences in pressure, at least by means of the rather crude method of measurement employed. The *Ss* of higher intelligence exert slightly less pressure than do those of lower intelligence, but the differences are not statistically reliable except in the case of working alone in Series 2 (the difference in average score here is 1.45, P.E.$_{diff.}$ .314, crit. ratio (4.62). At least we can say that the high group tends to press down less hard in tracing the maze than the low group.

Individual differences among groups seem to play some rôle in determining the amount of pressure regardless of whether the conditions are those of working alone or in pairs. These individual differences may be seen in Table XI. Here the low group, working in pairs for successive periods, exerts more pressure than the low

TABLE XI

AVERAGE PRESSURE-SCORES OF SUBGROUPS A AND B DURING PERIODS 1, 2 AND 3 OF SERIES 1

Group	Subgroup	Practice	Av. score	Diff.	P.E.$_{diff.}$	Crit. ratio
Low	A	*a*	8.53±1.92	1.53	.281	5.43
	B	*t*	10.06±1.43			
High	A	*a*	8.40±2.22	1.3	.332	3.92
	B	*t*	7.10±1.36			

group working alone for these periods, while the opposite is true for the high groups, the high group working alone exerts more pressure. Consequently, within the limits of this method, we may say that our results are negative in showing a relationship between amount of pressure and social facilitation.

Dominance between partners. We made one more comparison in order to look for possible effects of social facilitation. We studied the performance of the *Ss* who acted as partners, calling the partner who excelled in speed the dominant member, and the one who lagged behind the submissive member. We found the percentage of times that the dominant member excelled the submissive in performance. Equal performance of the members of a pair, which occurred very rarely, was excluded.

The frequencies for the different subgroups in Series 1 and 2 were computed together. The results are shown in Table XII.

The submissive partner excels the dominant partner more frequently under the conditions of working together, although the difference is only slight for the low group. In the high group, the submissive partner excels the dominant partner more frequently than she does in the low group, either when working alone or in pairs; but when working in pairs, the submissive partner is particularly stimulated. These results give evidence that social facilitation is more operative among the *Ss* of higher intelligence, particularly in stimulating competition between partners.

TABLE XII

PERCENTAGE OF TIMES THAT DOMINANT AND SUBMISSIVE *Ss* EXCEL IN THEIR PERFORMANCES

Group	Working alone		Working together in pairs	
	% Dom. excels	% Sub. excels	% Dom. excels	% Sub. excels
Low	83	17	78	22
High	72	28	59	41

DISCUSSION

Social facilitation has been explained in two ways, as being due to either ideo-motor activity or to rivalry and competition. Some authors as Moede, and Sengupta and Sinha have stressed the influence of the former, where the mere perception of the overt behavior of others causes *S* to do as the others do. Other investigators, Allport, Dashiell, and Ichheiser have emphasized the importance of the competitive attitude in enhancing social facilitation.[11] Of course, as Dashiell has pointed out, social attitudes such as competitive set, may be present when *S* works alone, or when he is under the scrutiny of an observer.[12]

We feel that both factors, ideo-motor activity and the awareness of conceptual goals influence performance. In our experiment then, we might say that ideo-motor activity and competitive attitudes influence both the *Ss* of lower and of higher intelligence and that this influence was stronger in the case of the latter, the more intelligent subnormal girls. It would seem, though, that an added explanation is needed to account for the fact that the less intelligent group of *Ss* profits relatively less from social facilitation than does the higher group. One explanation is that the less intelligent girls show greater egocentrism and rigidity in adapting to new situations. In a novel environment, their field of activity is more restricted than that of more intelligent *Ss*. In this experiment, for instance, the *Ss* in the high group asked many questions about the nature of the task and

[11] G. Ichheiser, Über die Veränderung der Leistungsbereitschaft durch das Bewusstsein, einen Zuschauer zu haben, *Psychotech. Zsch.*, 5, 1930, 52-54.

[12] Dashiell, *op. cit.*, 198.

about the scores made, their own scores and those of their partners. (Their questions, naturally, were never answered explicitly.) Also, the higher group coöperated voluntarily with the experimenter in the different tasks to be done, *e.g.* changing papers and fixing pencils. With rare exceptions, the *Ss* in the less intelligent group showed none of these overt manifestations of a wider range of activity. They sometimes asked how many trials they were to have but, in general, they concentrated on the task in hand of tracing the maze.

Nevertheless, in spite of their greater egocentrism and rigidity, a narrower field of activity and less overt participation in the more socialized aspects of the experimental setting, the less intelligent group was greatly influenced by the social facilitation of working in pairs. Still, the more intelligent girls had the advantage. Because of their more socialized attitudes, greater adaptablity to and understanding of the significance of a social situation, the more intelligent group profited more from the social facilitation of working in pairs.

Summary of Results

(1) Two groups of *Ss* with subnormal intelligence, a lower group with IQ from 50-59, and a higher group with IQ from 70-79, profit quite consistantly from the influence of working in pairs rather than working alone on a paper and pencil maze.

(2) The more intelligent *Ss* profit more from social facilitation than do the less intelligent *Ss*. This can be seen by the fact that the high group does relatively better under social stimulation than it does in working alone, if its scores are compared with corresponding scores for the low group.

(3) The high group, which is capable of performance superior to the low group, does not, however, do as well after three experimental periods of working alone as does the low group that has had the social stimulation during that time. In one subsequent period of social stimulation, the performance of the high group becomes decidedly superior, however, to that of the low group.

(4) More frequent social stimulation in an initial series makes for superior performance in a later series even without social stimulation. This holds true for both the higher and lower intelligence levels.

(5) Pressure as measured by the number of carbon impressions was not influenced by the condition of social facilitation. The *Ss* with higher intelligence exerted less pressure than did those of lower intelligence re-

gardless of whether they were working alone or in pairs. The differences, however, were not statistically reliable.

(6) The influence of greater social facilitation among the *Ss* of higher subnormal intelligence was also seen by the frequency with which the partners excelled each other. In the higher group, the submissive or slower partner excelled the dominant or faster partner much more frequently under the conditions of working in pairs than was the case for the *Ss* of lower subnormal intelligence.

THE EFFECT OF PAIN UPON SYSTEMIC ARTERIAL BLOOD PRESSURE

By JOHN PAUL NAFE AND KENNETH S. WAGONER, Washington University

In studies of emotional reactions, Landis and Gullette report an experiment upon emotional reactions in which, among other types of stimuli, the subjects were given electrical shocks which produced severe pain.[1] They found an increase in systolic blood pressure in most such cases, but they attribute these effects largely to accompanying muscular activity. Their data show that 12 of the 21 *Ss* showed a drop. The part of the experiment in which electrical pain-shocks were given followed approximately 3 hr. of various experimental situations and the *Ss* also were required to do mental multiplication while the shocks were administered. These conditions probably are not the best ones under which to determine specifically the effect of electrical or pain-stimuli upon blood pressure. Landis reports another experiment in which electrical stimulation of the faradic type was given to 3 *Ss* who were required to fast and were not allowed to sleep for 24 hr. before the administration of the shocks. "The current was made as strong as the subject was able to bear without struggling. Stimulation continued until he felt that he could endure the pain no longer."[2] The author points out that this situation results in a rapid initial rise in blood pressure, then a gradual fall of pulse pressure as stimulation continued and when the stimulation ceased the systolic pressure gradually fell.[3] One *S*, however, showed a marked decrease in systolic pressure at the beginning of stimulation. From the data given it is difficult to determine the actual blood pressure changes before, during and after stimulation with respect to the individual's normal or average blood pressure. Heinbecker, Bishop, and O'Leary, investigating pain and touch fibers in peripheral nerves found that with dogs "there was with one exception a sharp rise of blood pressure at the same approximate threshold as for pain, although with weaker stimuli rises were sometimes observed, usually followed by a fall at the end of stimulation."[4]

The present problem is designed to discover relationships between sensi-

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[1] Carney Landis and R. Gullette, Studies of emotional reactions: III. Systolic blood pressure and inspiration-expiration ratios, *J. Comp. Psychol.*, 5, 1925, 221-253.

[2] Carney Landis, Studies of emotional reactions: V. Severe emotional upset, *ibid.*, 6, 1926, 224.

[3] *Ibid.*, 241.

[4] Peter Heinbecker, G. H. Bishop, and J. O. O'Leary, Pain and touch fibers in peripheral nerves, *Arch. Neurol. & Psychiat.*, 29, 1933, 778.

tivity to pain and changes in blood pressure. Of the many kinds of pain we have not attempted to distinguish types but, because we have no guarantee that all kinds of pain derive from similar conditions, we have used some different types of stimuli to arouse it. We have attempted, as far as possible, to keep the stimulating situations clear of changes other than those involved in arousing pain.

METHOD AND PROCEDURE

A slight modification of the Erlanger method of blood pressure recording was used to investigate changes in blood pressure. The pressure cuff, wrapped around the arm, was connected to a Dunlap reducing capsule which in turn was connected to a Marey type recording tambour. The rubber membranes between the two chambers of the reducing capsule were adjusted to give maximum oscillations of the recording needle. A needle valve was inserted into the tube from the upper chamber of the reducing capsule to the tambour so that the pressure in this system might be kept at atmospheric pressure except during those changes caused by the pulse waves. Blood pressure was determined and a cuff was then placed on each of *S*'s arms, one inflated to subsystolic pressure and the other to subdiastolic pressure. An increase in the systolic pressure is shown by an increase in the height (amplitude) of the record tracing and an increase in diastolic pressure, recorded from the opposite cuff, is shown by a decrease in the height of the tracing. Conversely a fall in systolic pressure is shown by a decrease in the height of the tracing and a fall in diastolic pressure is accompanied by an increase in the height of the record tracing. When both pressures are simultaneously recorded, a decrease in the subdiastolic tracing with an increase in the subsystolic tracing indicates an increase in arterial pressure.

A pneumograph, of the Harvard type, was used to record respiratory changes since a record of breathing taken with blood pressure changes provide a check on pressure changes which might be influenced by or correlated with changes normal during respiration.[5] Furthermore, it provides a check whereby any characteristic pattern of breathing associated with pain stimulation may be noted.

Electrical pain-stimulations were given by means of an inductorium. The primary circuit was energized by 6.3 volts using a 60~ interrupter in order that the makes and breaks would be constant. Between the secondary leads of the inductorium and the electrodes an attenuator was used to control the intensity of the delivered shock.[6] In this manner the intensity could be varied from an almost imperceptible shock to an extremely painful one and the exact intensity for any shock could be read from the attenuator dial and translated into current units from a calibration curve of the inductorium. The attenuator permitted the current to be regulated between the limits of 0.0001 milliamperes to 0.2 milliamperes. An average current of 0.12 to 0.16 milliamperes was usually sufficient to produce a definitely painful experience. The dial positions on the attenuator corresponded to approximately 0.15 milliamperes. Stimulation was made with platinum electrodes projecting about 10 mm. from a hard

[5] Peter Heinbecker, The mechanism of the respiratory waves in systemic arterial blood pressure, *Amer. J. Physiol.*, 81, 1927, 170-181.

[6] The wiring diagram is shown in an earlier article, J. P. Nafe and K. S. Wagoner, The effect of pain upon peripheral blood volume, this JOURNAL, 51, 1937, 119.

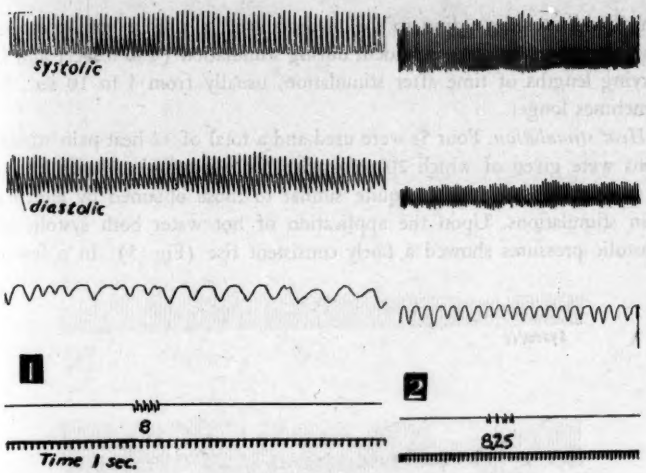
rubber handle (Harvard type) with points spaced approximately 1 mm. apart. The intensity of each shock administered to the *S* was noted on the kymograph records in terms of the attenuator dial units. The approximate amount of current which would produce definite pain-sensations in a particular *S* was determined in preliminary tests and during the experiments *S*'s report of the intensity of his pains was always taken. Stimulation was effected by bringing the electrodes into contact with the skin of the back of the hand or the calf of the leg and the weight of the stimulator (11.4 grm.) determined the pressure with which it was applied and consequently was practically the same in all cases. Application was made for varying lengths of time, usually with about 3 or 4 successive applications of about 1 sec. each. Alternate stimulations were usually made on one hand and the *S*s were instructed to avoid jumping or moving during any part of the experiment, especially at the time of stimulation.

Stimulation with heat was accomplished with heated air and water. Hot air stimulation was given by means of a small blower terminating in a tube about 1 in. in diam. It consisted of a nichrome wire coil energized by 110 volt A.C. Without any attempt accurately to measure the intensity of stimulation, from 3 to 5 sec. of application of the stream of hot air to the skin of the hand, arm or leg was sufficient to produce pain. In the case of hot water, a container of water of the desired temperature, 45° to 58° C., was raised over one hand which hung down in a normal position at *S*'s side which permitted stimulation to be made without movement on the part of *S*. The approximate temperature necessary to produce pain was determined for each S in preliminary tests and control series were taken in which the temperature of the water was reduced to sub-painful temperatures.

Pain-stimulation was also given by the application of a sharp needle to the back of the hand. No attempt was made accurately to regulate or measure the intensity of stimulation. Seven *S*s, all young men of college age, were used. In all cases of stimulation ample time was allowed between tests for the blood pressure to return to normal. In most cases the reports indicated that this could have been determined by simple inspection of the kymograph record.

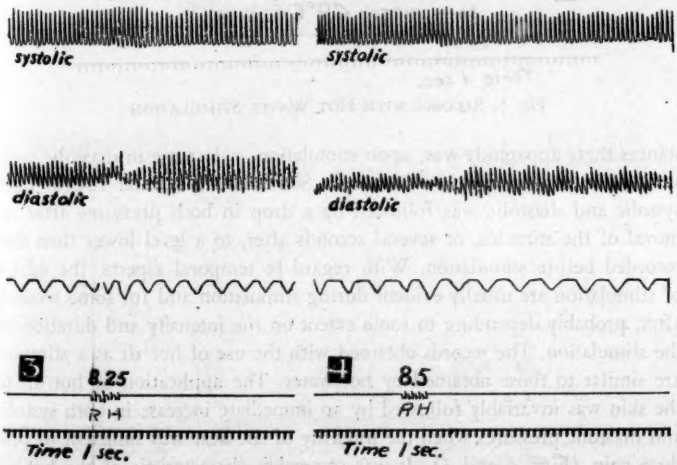
Results

Electrical stimulation. There was a total of 72 electrical pain stimulations given to 5 *S*s in this part of the experiment averaging about 14 stimulations to every *S*. The results were consistent in showing a rise in systolic blood pressure when the intensity of the stimulation was sufficient to produce pain. In most cases diastolic pressure showed changes paralleling those of systolic pressure (Figs. 1 and 2). In a few cases diastolic pressure showed changes which appeared to be independent of systolic pressure during, and for a few seconds after stimulation. Usually the rise in both systolic and diastolic pressures during and for some seconds after stimulation was followed by a decrease in both pressures to approximately normal, *i.e.* the level prevailing before stimulation. In some cases, however, the usual rise was followed by a fall in both pressures to a level somewhat below the original



FIGS. 1 AND 2. RECORDS WITH ELECTRICAL STIMULATION

level obtained before stimulation (Figs. 3 and 4) due, presumably, to normal fluctuations in pressure during the test. The effect of stimulation upon both pressures was usually immediately evident in the increased amplitude of the systolic tracings and in the decreased amplitude of the diastolic tracings



FIGS. 3 AND 4. SHOWING LOWER LEVELS AFTER ELECTRICAL STIMULATION

which indicates, according to the method used, a rise in both pressures. This rise continued or was evident during stimulation (4 to 6 sec.) and for varying lengths of time after stimulation, usually from 4 to 10 sec., but sometimes longer.

Heat stimulation. Four *S*s were used and a total of 32 heat-pain stimulations were given of which 20 were with hot water and 10 with hot air. In general the results were quite similar to those obtained by electrical-pain stimulations. Upon the application of hot water both systolic and diastolic pressures showed a fairly consistent rise (Fig. 5). In a few in-

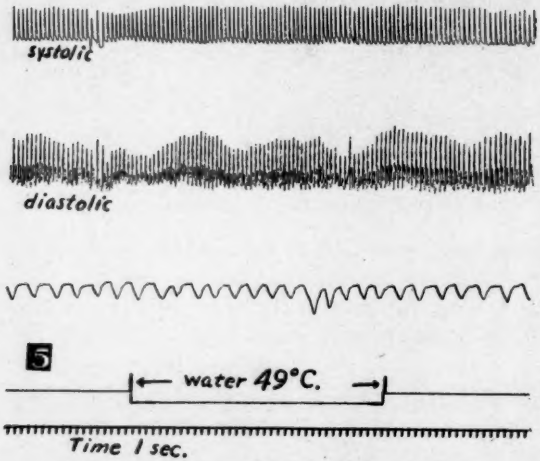
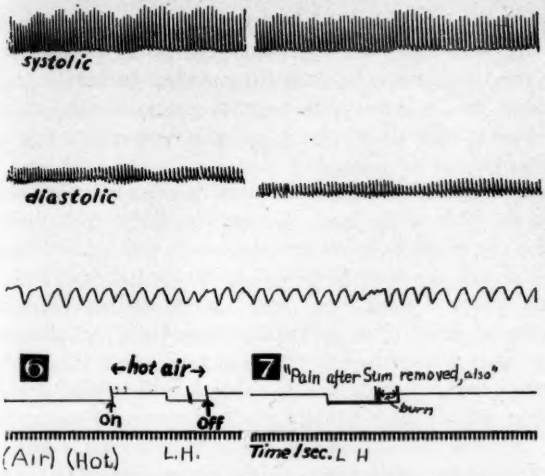


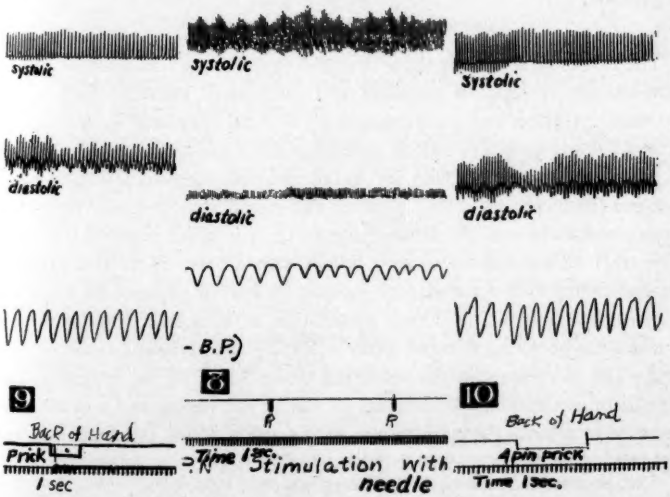
FIG. 5. RECORDS WITH HOT WATER STIMULATION

stances there apparently was, upon stimulation, a decrease in diastolic pressure while systolic pressure increased. Sometimes the usual rise in both systolic and diastolic was followed by a drop in both pressures after removal of the stimulus, or several seconds after, to a level lower than that recorded before stimulation. With regard to temporal aspects, the effects of stimulation are usually evident during stimulation and for some seconds after, probably depending to some extent on the intensity and duration of the stimulation. The records obtained with the use of hot air as a stimulus are similar to those obtained by hot water. The application of hot air to the skin was invariably followed by an immediate increase in both systolic and diastolic pressures when the intensity of the heat was sufficient to produce pain (Figs. 6 and 7). It was somewhat characteristic of the hot air stimulations that the effects extended over a longer period of time than



FIGS. 6 AND 7. RECORDS WITH HOT AIR STIMULATION

other types of stimuli in proportion to the duration of the stimulation and in about half the cases the greatest rise in pressure occurred, together with S's report of greatest pain, one or two seconds after the removal of the stimulus. As in the two previous types of stimulation, in some cases the



FIGS. 8, 9, AND 10. RECORDS WITH NEEDLE PRICK STIMULATION

records show a slight decrease in both systolic and diastolic pressures several seconds after stimulation to a level lower than before stimulation. Again, however, this decrease may be attributed to normal fluctuations in pressure which might have occurred over a similar period of time without any stimulation. It is uncertain whether or not such decreases are significant for the present study.

Stimulation with needle. Pain produced by the application of a sharp needle to the back of the hand also was invariably accompanied by an appreciable rise in systolic blood pressure, usually accompanied by a similar change in diastolic pressure (Figs. 8, 9, and 10). Forty-two such stimulations were given. A short latent period intervened between stimulation and a noticeable effect upon the blood pressure but a well defined rise in systolic pressure was usually evident within from 1 to 4 sec. after stimulation. Certain cases in which such stimulation did not elicit definite pain-responses served as a check upon the relation between the pain and pressure increase. In those cases reported by the *Ss* in which the stimulus elicited only very mild pain, or no pain at all, the rise in pressure was correspondingly very slight or entirely absent. The relationship between the intensity of the pain as reported and the rise in pressure as recorded was fairly consistent although not specifically investigated in this experiment.

Short stimulations such as those administered in this experiment resulted in no consistent increase in heart rate nor in any characteristic change in respiration.

Discussion

The results of this study show that both systolic and diastolic blood pressure increase under pain stimulation of fairly short duration. Such a rise in blood pressure may be produced by nervous, humoral or mechanical action but the specific effect of painful stimulation upon any of these *Ss* is not a part of this problem and is not definitely known. If the action is nervous the increase in blood pressure may be effected by either pressor or vasoconstrictor fibers. As Howell suggests,[7] it is quite possible that such (painful) stimulation of sensory nerves may reflexly excite the vasoconstrictor center with a consequent increase in arterial pressure by means of a peripheral constriction. Direct stimulation of vasoconstrictor fibers produces a rise of pressure in the artery supplying the particular organ or area and a fall of pressure in the veins, indicating action of the arterioles. The constriction results in a diminution in size of the vessels and a consequent increase in arterial pressure. When such a reflex action is set up it is not

[7] W. H. Howell, *Textbook of Physiology*, 12th ed., 1934, 1132.

likely to be limited to the part stimulated but the degree of constriction and the area involved for any given case are uncertain except that our studies indicate a fairly definite relation between the degree of constriction and intensity of stimulation. If constriction of the blood vessels over a fairly large area does occur with sensations of pain in response to stimulation of the skin at certain intensities, the question of an essential relationship must arise. It has been shown that severe constriction of the blood vessels, set up by stimulation with heat, arouses pain, a type of pain which cannot occur in the absence of blood vessels. On the other hand pain may be aroused in the non-vascular cornea of the eye,[8] but even in such cases the generalized peripheral constriction presumably occurs. It is unlikely that the amount of constriction produced in areas far removed are usually involved in pain localized at the point of stimulation, but the amount of constriction produced appears to vary directly with the intensity of stimulation and hence it is possible, in cases of extreme pain, that constriction in areas at some distance may help to account for irradiated pain.

The differences found in the duration of the effect of stimulation upon blood pressure may be due to a number of factors such as duration or intensity of stimulation, individual differences in the *S*, degree of expectancy, and varying physiological conditions. These relationships were not made a part of the present study.

Conclusions

The results of this experiment tend to show that:

(1) Pain aroused by faradic stimulation of the skin or by stimulation with heat or by pricking the skin with a needle is consistently accompanied by a rise in systolic blood pressure.

(2) In general, diastolic blood pressure shows changes paralleling those of systolic pressure.

(3) The two previous conclusions warrant the generalization that cutaneous pain is accompanied by a rise in arterial blood pressure.

(4) In some cases, diastolic pressure changes do not appear to parallel those of systolic pressure and in some cases the rise in one pressure is apparently somewhat greater than in the other.

(5) Stimulations administered in this experiment did not appear to produce a consistent increase in heart rate.

(6) There is no indication from the records that the changes in blood pressure due to stimulation may be attributed to respiratory reactions.

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[8] J. P. Nafe and K. S. Wagoner, The effect of thermal stimulation upon dilation and constriction of the blood vessels of the skin of a contralateral hand, *J. Psychol.*, 2, 1936, 461-477.

SEX DIFFERENCES IN THE PERCEPTION OF COLOR MASS

By B. R. PHILIP, University of Alberta

The determination of genuine sex differences in psychological abilities is beset with many pitfalls. Often when differences of statistical reliability are found one cannot be certain that they are genuine. It is difficult to eliminate spurious factors which tend to give differences statistically reliable enough, but which are complicated by variables such as age, intelligence, training, motivation or personality.

Much depends upon the particular test selected to measure the ability to be compared. A test reported by the author seems to prove fairly satisfactory for the determination of the perceptive ability of color mass.[1] The effect of age and intelligence is very slight, and the test seems of fair reliability. Personality factors of course are of importance, and much of the individual variability may be attributed to traits such as carelessness, and excitability. There is also evidence of personality traits which seem to be more characteristic of one sex than of the other, *e.g.* younger girls seem to do their tests with more care than do the boys of the same age.

Subjects. The test has been described in the original paper. The findings, obtained from 485 boys reported therein, are repeated here in tabular form for comparison with those of 204 girls from grades 5-8, and 130 university women and 365 university men. No selection was made of the *Ss* in any group. All available *Ss* in any grade or class were tested. Color blind *Ss* are often reluctant to be tested in color, but the

TABLE I

DISTRIBUTION OF AGES

(Age 12 is, for example, from 11 yr. 6 mo. to 12 yr. 5 mo.)

Ss	Age									T
	10	11	12	13	14	15	16	17	18	
Boys	15	21	77	73	81	76	73	47	22	485
Girls	21	30	48	51	32	18	5			205

data here presented is believed to be representative of a random sample. The age distributions of the boys and girls are given in Table I. No high school girls were tested; this is probably not a serious omission as no tendency of statistical reliability was found for the mean error score to decrease with increasing age, for either the boys or the girls. The difference between the norms of the adults and of the children is rather slight, and is probably to be attributed in large part to factors other than discriminatory ability of color mass.

RESULTS

The approximate decile scores for total errors in three trials are given in Table II. Fig. 1 gives the cumulative frequency curves of the four groups. It is to be noted that both table and figure show a consistent difference between the groups.

* Accepted for publication July 7, 1937.

[1] B. R. Philip, The discrimination of color mass, this JOURNAL, 51, 1938, 127-135

TABLE II

APPROXIMATE DECILE NORMS OF TOTAL ERRORS

(The score given is the minimum for each decile)

Ss	N	Decile										95%
		1	2	3	4	5	6	7	8	9	10	
Boys	485	—	18	21	24	26	28	31	33	37	42	48
Girls	204	—	17	20	22	24	26	28	31	34	38	44
Men	365	—	15	19	21	23	25	26	28	31	35	40
Women	130	—	13	16	19	20	22	24	26	29	33	38

At every decile the order of ability is boys, girls, men, women. The figure shows, for boys and for men, an abrupt skewness at the 95th. percentile due to the color blindness of the poorest group. Less than 1% of the girls and women are color blind, and hence the skewness does not appear in their curves.

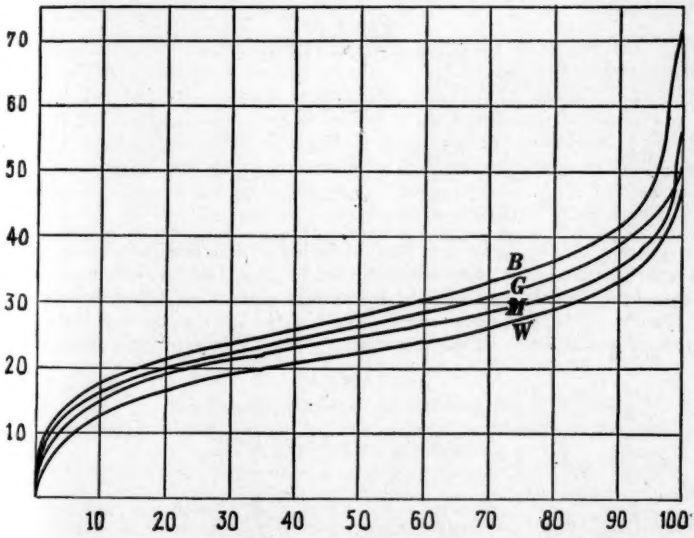


FIG. 1. CUMULATIVE FREQUENCY PERCENTILES OF TOTAL ERRORS

B. G. M. and W = Curves of boys, girls, men and women respectively. The color-blind boys and men account for the skewness at the 95th. percentile in curves B and M.

Tables III and IV list the mean errors and the mean times in seconds per trial. Roughly there is a 10% reduction in times and errors from trial to trial. The group differences so consistently found in Table I are to be noted here, with the exception that the times for the boys are faster than those of the girls.

Chronological age has but very little effect upon the error score. Increasing age does not greatly improve the ability to discriminate color. It does make for greater

caution and more prolonged concentration in sorting the cards, so that the total error score is cut down slightly. The main function of age seems to be to diminish the time taken for the test since the curvilinear correlation between time and chronological age for boys was found to be 0.3 ± 0.03 for all three trials. In spite of the greater mean age of the boys, 14.2 yr. as against 12.6 yr. the girls discriminate color

TABLE III

MEAN ERRORS PER TRIAL

Ss	Trial 1	Trial 2	Trial 3	Total	σ_{Dis}	σ_M
Boys	10.7	9.6	8.3	29.1	13.5	0.61
Girls	9.4	8.5	7.8	26.2	8.5	0.60
Men	9.2	7.9	7.0	24.6	8.3	0.44
Women	8.4	7.5	6.6	22.7	8.2	0.72

TABLE IV

MEAN TIMES (IN SEC.) PER TRIAL

Ss	Trial 1	Trial 2	Trial 3	Total	σ_{Dis}	σ_M
Boys	142	125	115	373	104	4.7
Girls	149	128	121	390	86	6.1
Men	133	126	124	340	92	4.8
Women	112	96	92	296	84	7.4

mass better, but take longer time than do the boys. The critical ratios of the differences of the means is 3.34 for errors and 2.22 for time. That the faster work of the boys depends mostly on their increased age and is not a sex linked difference, is shown by the fact that the women are considerably faster than the men, the critical ratio of the difference of the means being 4.58. The women make fewer errors

TABLE V

INTERCORRELATIONS OF THE ERRORS PER TRIAL

(r_{12}, r_{23}, r_{13} = Correlations of 1st. and 2nd., 2nd. and 3rd., and 1st. and 3rd. trials respectively; r_{11} = Reliability of Test)

	r_{12}	r_{23}	r_{13}	r_{11}
Boys	0.51	0.48	0.36	0.71
Girls	0.46	0.47	0.40	0.70
Men	0.40	0.45	0.39	0.68
Women	0.50	0.52	0.44	0.74
P.E.		0.04–0.05		0.01

than do the men, the critical ratio of the difference is 2.31. Had more women taken the test, about 300 instead of 130, it is felt that the critical ratio for errors would also be statistically reliable.[2]

[2] The greater number of color-blind among the men and boys contributes but slightly to the differences in the means. When medians instead of means are used to obtain the differences Fisher's criterion of significance is still satisfied and the critical ratios are not greatly changed.

On the basis of these facts the conclusion is that girls and women discriminate color mass more accurately than do boys and men, making from 8–11% fewer errors. Better discrimination in general makes for faster times, and the women are not only more accurate but are faster than the men. The boys, however, are faster than the girls because their greater age and tendency to recklessness more than counterbalance the delay caused by the greater number of errors they make.

TABLE VI

INTERCORRELATIONS OF THE TIME PER TRIAL

	r_{12}	r_{23}	r_{13}	r_{11}
Boys	0.67	0.66	0.76	0.88
Girls	0.50	0.53	0.38	0.73
Men	0.72	0.77	0.52	0.86
Women	0.71	0.80	0.70	0.90
P.E.		0.02–0.04		0.01

Tables V and VI give the intercorrelations for time and for errors of all three trials, and the reliability of the test based upon the Spearman-Brown formula. It is to be noted that the reliability is greater for time than for errors, and that the highest intercorrelations are generally yielded by the second and third trials.

Analysis of errors. In the first report an interesting relationship was found between the relative amount of predominating color and the frequency of errors, *i.e.* between difficulty and error frequency. A curve of the form $Y = 78/X^{-0.28}$ was fitted to the data for the boys, where X = percentage of errors, and Y = percentage of predominating color. Table VII lists the percentage of errors made

TABLE VII

PERCENTAGE FREQUENCY OF ERRORS PER TYPE OF CARD

Type of card	X=Color (%)	Y=frequency of errors (%)			
		Boys	Girls	Men	Women
18	50.0	4.4	2.4	1.8	1.4
16	44.5	9.9	8.2	6.8	6.4
14	39.0	15.6	14.00	12.0	11.5
12	33.3	27.2	27.9	28.3	28.1
11	30.5	43.0	47.6	51.2	52.5
P.		98	90	90	85
Equation		$Y=1228e^{-0.112x}$	$Y=3819e^{-0.144x}$	$Y=6957e^{-0.162x}$	$Y=11511e^{-0.176x}$

by each group on the different types of cards. Several types of curves were fitted to the data by the method of least squares and the equation selected is of the form $Y = ae^{bx}$ where X = % of predominating color and Y = % of errors. The table gives the exponential equations and Pearson's P for goodness of fit.

Fig. 2 is the plot of the curves showing the relationship between percentage of predominating color and percentage of total errors. The curves are all exponential, with limiting values at X = 26 and Y = 0 approximately corresponding to Y = 100 and X = 100 respectively. These limiting values imply that if one type of card were such that the predominating color were very slightly in excess of the three other colors, practically all the errors would be made on that type of

card; and that no errors would be made if the cards were almost exclusively of the one color. From the curves it can be seen also that only 1% of the total errors would be made if the predominating color were 63, 57, 55 and 53% of the

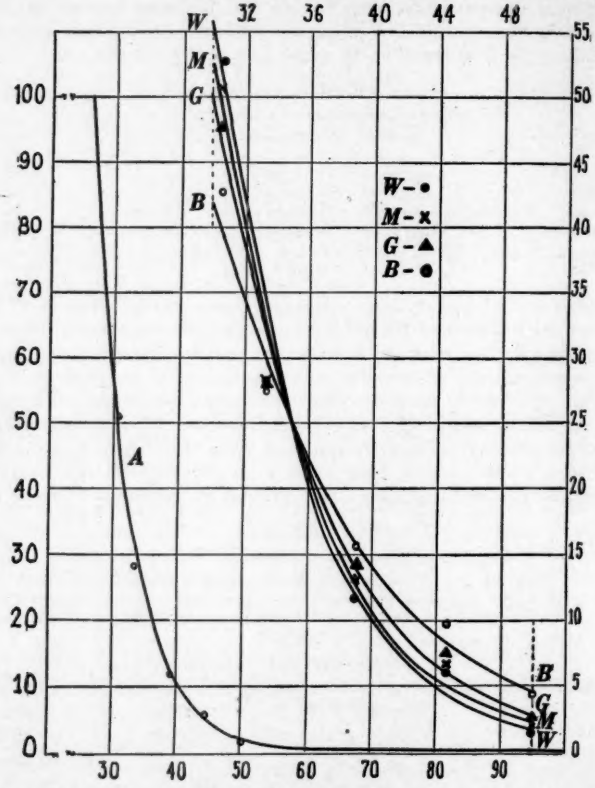


FIG. 2. RELATIONSHIP BETWEEN DIFFICULTY AND ERROR FREQUENCY
Abscissae = percentage of predominating color of cards; ordinates = percentage of error; A = complete curve for group of 465 men; W, M, B, and G = Segments of enlarged curves for groups of women, men, boys, and girls, respectively. Values at left and bottom refer to curve A. Values at right and top refer to curves W, M, B, and G.

total color for boys, girls, men and women respectively—values in accordance with the discriminative ability of the various groups. It is to be borne in mind that these values are extrapolations based on data found for five points on the curve and that changing the difficulty of the cards might considerably shift the percentage

of errors made on each type of card. The extrapolated values found, however, check well with what one would expect, for the equations are meaningless for points beyond the limiting values by the very nature of the task. The significant fact is that the relationship between the physical amount of color and the psychological perception as determined by the percentage of error may be adequately expressed by an exponential function.

Table VIII lists the number of errors made on each type of card using the percentages of the previous table, and the mean number of errors made by each group. It is to be noted that all the groups of *Ss* make very closely the same number of errors (12.5) on the most difficult type of card (Type 11), and the difference between the groups consists chiefly in the increasing number of errors made on the easiest types of cards.

In part this may be explained as follows. An error may be due to a number of factors: a principal one, defective perceptive ability, which remains fairly constant

TABLE VIII

NUMBER OF ERRORS PER TYPE OF CARD

	Type					Total
	18	16	14	12	11	
Predominating color (%)	50.0	44.5	39.0	33.3	30.5	
Boys	1.28	2.84	4.52	7.88	12.76	29.98
Girls	.63	2.15	3.66	7.30	12.48	26.10
Men	.44	1.67	2.95	6.97	12.60	24.63
Women	.32	1.45	2.61	6.36	11.90	22.64

for the same *S* under a given set of conditions, and subsidiary factors prone to fluctuate rather randomly, which may be grouped broadly under such names as attention, personality, set, and speed variations. The subsidiary factors are difficult to control and their importance may be gauged from the deficiency of the tests from perfect reliability. Were the random factors not operating to the extent they do the reliability and the mathematical relationship between difficulty and frequency of error would be almost perfect. Furthermore, the perceptive ability is greater in relation to the subsidiary random factors for the easier cards and this relationship varies almost inversely as the difficulty of the cards. As a consequence, on the most difficult cards (the 11 and 12 series), perceptive ability has less weight in proportion to the random factors and all groups make approximately the same number of errors. Hence the superiority of women over men, and girls over boys is most marked on the easiest series (Types 18, 16, and 14).

Confusion colors. Table IX lists the types of confusion colors. It is to be noted that there is a surprising similarity in the frequency of errors of the same types, with no clear-cut difference between the sexes or between children and adults. Any variation is probably due to the difference in ability between the groups. In the previous paper it was shown that there is a difference between the boys of the various quartiles in the types of errors they make—the poorer *Ss* are more prone to confuse all colors nearly to the same extent. For all groups of *Ss* red and blue rarely act as confusion colors for the others, and yet these colors are the ones most often mis-

TABLE IX

CONFUSION COLORS AS PERCENTAGES OF TOTAL ERRORS

Ss	Confusion colors	Predominating color				Total
		Blue	Green	Purple	Red	
Boys	Blue	—	3.8	7.0	3.1	13.9
	Green	12.4	—	13.5	8.6	34.5
	Purple	24.4	7.4	—	7.6	39.4
	Red	4.5	3.1	4.5	—	12.1
	Total	41.3	14.3	25.0	19.3	
Girls	Blue	—	3.1	3.9	3.0	10.0
	Green	11.5	—	11.8	9.7	33.0
	Purple	27.6	9.6	—	10.2	47.4
	Red	4.0	2.2	3.4	—	9.6
	Total	43.1	14.9	19.1	22.9	
Men	Blue	—	2.8	4.5	2.4	9.7
	Green	11.5	—	12.2	11.5	33.3
	Purple	27.4	9.5	—	11.8	48.7
	Red	2.4	2.2	3.5	—	8.1
	Total	39.4	14.5	20.2	25.7	
Women	Blue	—	2.8	4.5	2.1	9.4
	Green	9.4	—	12.3	11.8	33.5
	Purple	25.9	9.0	—	13.5	48.4
	Red	2.8	2.1	3.4	—	8.3
	Total	38.1	13.9	20.2	27.4	

judged. One quarter of the errors are made in mistaking the blue cards for the purple.

DISCUSSION

As was stated in the original paper the ability tested is not that of the discrimination of the individual components of color, *i.e.* hue, saturation and brightness, but rather the discrimination of what may be called color mass. Areas to be compared are distributed into elements of equal area so separated that their colors affect each other in a complex manner. Nevertheless the discrimination of the predominating color is a task well within the powers of the youngest children tested, while exacting the keenest perceptions from adults. While discrimination of color mass is believed to be a good index of general perceptive ability of color the conclusions formulated in this paper are applied only to the task selected.

The consistency of the findings from group to group even more than the critical ratios of the reliability of the differences between the means indicates a slight but definite superiority of females over males in the perception of color mass. The novelty of the task whereby previous practice or experience is largely eliminated, and the negligible improvement with age suggest that the ability to discriminate color mass is maximal for the individual relatively early in life. Intelligence and age play only a subsidiary rôle in the discrimination of color mass, and make for better adaptation, faster speed and more adequate concentration without significantly improving the score.

APPARATUS

A PORTABLE BOLTHEAD MAZE

By HERBERT GURNEE, Western Reserve University

The bolthead maze possesses several advantages as an instrument for the investigation of human learning. It permits *S* to use his eyes and thus it is more natural and less disconcerting than mazes which require a blindfold. It admits of diverse methods (*e.g.* light, sound, shock) of informing S of right and wrong responses. It may be varied in length or pattern of pathway, and in location of start or goal.

The model here described was constructed primarily for use in our course in experimental psychology. The panel is five-ply maple, 1 cm. thick and 28 cm. square, with a projection 10 cm. long and 2½ cm. wide at the middle of one end to carry

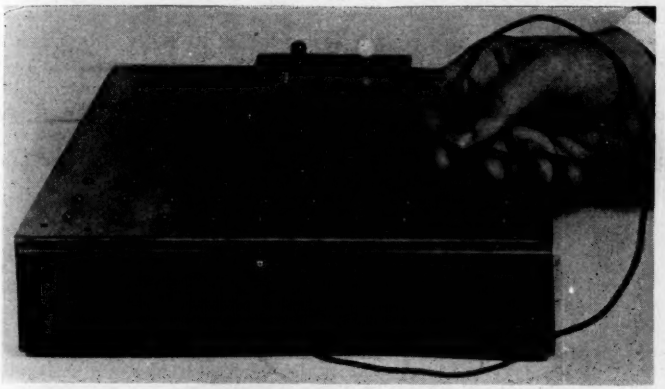


FIG. 1. PORTABLE BOLTHEAD MAZE

the light sockets. Wood was chosen for the panel instead of bakelite because it is cheaper and can be sandpapered and reshellacked when it becomes marked or scratched. The bolts are ¾ in. x ⅛ in. round head brass. There are 100 of them in rows of 10 set 2½ cm. apart, center to center, each way. If several mazes are made at one time (we made twelve), the panel-boards may be clamped together and all the holes drilled at once. The boards are then sandpapered and shellacked twice before the bolts are inserted. The start and goal may be indicated by labelling, or, as in the model shown, by washers under the boltheads. It makes for a more durable instrument, however, if washers are placed under all boltheads; there is then less likelihood of the wood becoming marred by the pointer.

The box is 6 cm. deep and is made of ½-in. white pine, painted black. A rubber tack-bumper is placed at each corner of the bottom to prevent scratching of furniture

and slipping. The light sockets are miniature size and are recessed from below, although this is not necessary. The lamps are mazda no. 233 (2.3 volts) flashlight bulbs. One is lacquered red (errors) and the other white (correct path). Current is furnished by 2 flashlight batteries set in metal clips inside the box.

The pointer is a 3-in. copper wire nail, with the head cut off and a piece of lamp-cord soldered to the end. A short piece of rubber tubing is slipped over the nail to provide a grip.

Any pattern of bolts may be chosen for the correct pathway, which is wired on the back of the panel and placed in circuit with the pointer and the white light. All other bolts are wired in circuit with the pointer and the red light. Our usual set-up requires *S* to proceed by adjacent bolts, from start to goal, up, down, right or left, but not diagonally. When a right left flashes, he must go back to the last white light. The main criterion of learning is the reduction of the number of red lights during the required trials.

If signals other than the lights are desired, the bulbs may be removed and connections made to the socket terminals. Shock may be introduced by using, as one secondary electrode, a thin sheet of brass or copper around the rubber grip on the pointer.

One defect with this type of maze is that the correct pathway, by reason of greater use, may accumulate in the course of time slight distinguishing marks which will serve as cues to the subject. This possibility can be considerably diminished by brushing all boltheads occasionally with very fine sandpaper; in any case such brushing ought to be done now and then to ensure clean contacts. We have a large bolthead maze which was used by many thousands of visitors at the Great Lakes Exposition without any noticeable effect in marking the right pathway.

A MANUAL PURSUIT-OSCILLATOR

By ROLAND C. TRAVIS, Western Reserve University

The manual pursuit-oscillator is an apparatus for the study of motor learning in eye-hand coördination. It has been described briefly in previous reports.[1] The purpose of this communication is to give a more detailed description of a piece of laboratory apparatus useful in studying motor learning. Fig. 1 shows the essentials of the pursuit-oscillator in outline form. A small bakelite platform (15 cm. by 20 cm.), carrying a silver target (12 mm. in diam.) sunk flush with the surface of the platform, is mounted on a pivoted support which is attached to a crank and pulley on one axle of a speed reducer. The other axle and pulley of the speed reducer is connected to a synchronous motor by a V-belt. This arrangement permits the platform to be oscillated through an arc which can be increased or decreased by simple adjustment of the eccentric on the driving pulley. The speed of oscillation of the platform can be varied by adjustment of the motor belt on the cone pulleys. In all our

[1] R. C. Travis, The effect of the length of the rest period on motor learning, *J. Psychol.*, 3, 1936, 189-194; R. C. Travis and H. Anderson, The effect of electric shock on learning in eye-hand coördination, *J. Exper. Psychol.*; (in press).

experiments the speed was one complete oscillation in 1 sec. through an arc of 13°, and the target was mounted 46 cm. from the center of rotation.

S's task was to stand before the oscillating platform, which was about waist high, and to hold the gravity-stylus on the oscillating target. The gravity-stylus was hinged in the center to permit the bent brass pointer (12 gauge wire, 13 cm. long, bent 3.5 cm. from the end) to move freely in the vertical plane while the wooden handle was held by *S*. This type of stylus is held lightly in the hand with no greater pressure brought to bear on the target than the weight of the brass wire. Whenever the stylus is in contact with the target, the electric recording device is activated and

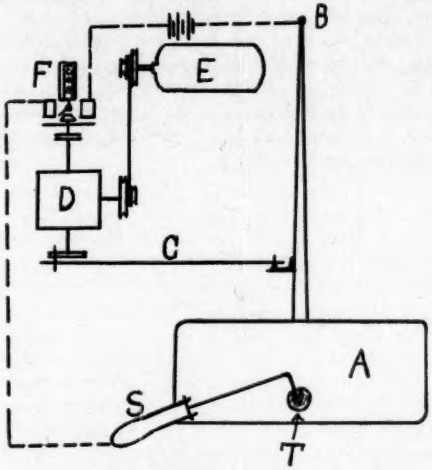


FIG. 1. MANUAL PURSUIT-OSCILLATOR

A, Bakelite platform, 15 by 20 cm.; *B*, axis of rotation of the platform, 46 cm. from the target, *T*; *S*, gravity stylus, hinged in center; *C*, crank; *D*, speed reducer, Boston Gears Works, 10 to 1; *E*, electric motor, 1800 r.p.m. (reduction between motor and reducer was 3 to 1); *F*, electro-magnetic counter.

the accuracy of manual pursuit is recorded. An additional motivating cue is provided by connecting a watch-case receiver in the same circuit with the stylus through a bell-ringer transformer. The 60~ tone is quite audible whenever the stylus is in contact with the target. The type of record of response depends on the purpose of the particular problem and on the type of recording device used (whether electric counter, smoked drum or photographic paper).

This apparatus combines the principles involved in the Koerth pursuit rotor[2] and the Miles pursuit meter[3] in that *S*'s task is to hold the flexible stylus on a moving target which oscillates in simple harmonic motion. In practice, the general pattern

[2] W. Koerth, A pursuit apparatus: eye-hand coördination, *Psychol. Monog.*, 31, 1922, (no. 140), 288-292.
[3] W. R. Miles, A pursuit pendulum, *Psychol. Rev.*, 27, 1920, 361-376.

of movement of the pursuit oscillator is superior to that of the Koerth pursuit rotor because the target of the pursuit oscillator accelerates and decelerates twice in each complete oscillation whereas the target of the Koerth pursuit rotor rotates at a constant velocity. The acceleration and deceleration phases of the target of the pursuit oscillator more closely resemble the natural movements of the eyes, hands and arms. This movement pattern of the target duplicates that of the Miles pursuit meter. The pursuit oscillator is more flexible, however, in that greatly different speeds and distances of the target may be obtained easily and quickly by simple adjustment. Furthermore, electro-magnetic counters, photographic paper or a smoked drum may be used to record the accuracy of oculo-manual pursuit. The electro-magnetic counter is very convenient, saves time and gives an accurate record of the total amount of performance for a given interval of time. For a fine, detailed analysis of the manual pursuit performance the smoked drum on a spiral kymograph is necessary, although consuming time in reading the records. Photographic registration is essential in recording simultaneously the movements of the target, the movements of the eyes and manual pursuit of the target. All three methods of recording have been used in studying motor learning in our laboratory.

APPARATUS NOTES

A Simple Hollerith Technique for Scoring Tests

It frequently happens in making a study of group responses, particularly on personality tests, that it is desirable to punch Hollerith cards for every individual so that the frequency of responses may be tabulated. It also frequently happens that the individual scores of the subjects who took the tests are desired. The following device is suggested as a means of scoring the tests by the use of the Hollerith cards themselves and without tabulating or sorting.

Suppose, for example, that some items of the test received a weight of +1 in the final score and some received a weight of —1. Place two Hollerith cards in the punching machine. Punch all items which are to receive a weight of —1 in the final tabulation. Remove the cards from the machine and paste between them a piece of blue-purple theatrical gelatine, such as is used in front of spot or flood lights. (This particular color has proved best suited for easy perception.) If the cards are now held up to the light the position of all of the items which received a weight of —1 will be seen in color. If the Hollerith card for any individual is placed over the stencil, the only holes which will appear will be those of the items which should receive a weight of —1.

Now place the stencil back in the punching machine and punch out all items which should receive a weight of +1 in the final scoring. If the card is now held up to the light the positions of all of the items which receive a weight of +1 will be indicated by white lights and the positions of all of those which receive a weight of —1 will be shown by the colored lights.

To score any test, therefore, all that is necessary to do is to place the test-card over the stencil, place the pair of cards against a window or any illuminated surface, and all of the items to receive a score of +1 will appear as white lights and all of the items to be scored —1 will appear as colored ones. All that remains to be done is to count the number of lights of each color and to treat them as the demands of the particular test dictate.

If the items of a test receive various weights, a series of stencils may be made showing the items which receive two different weights on each stencil. Thus it might be that on the first stencil the white lights receive a weight of 1 and the blue ones a weight of 2, on the second stencil the whites receive a weight of 3 and the blues a weight of 4, etc.

This method of scoring has proved very efficient and accurate and avoids handling the original tests more than the once when the individual Hollerith cards are made. It also avoids the difficulty of having to reinterpret the various markings on the tests which might be equivocal.

Stanford University

Robert T. Ross

NOTES AND DISCUSSIONS

THE SOCIETY OF EXPERIMENTAL PSYCHOLOGISTS: 1904–1938

The close of a decade of formal organic existence for the Society of Experimental Psychologists is an appropriate time at which to review the history of the Society, though that history begins, not in 1928, but in 1904, at Cornell, when Edward Bradford Titchener initiated the informal spring meetings of Experimental Psychologists.[1]

The Informal Meetings

The early group formed an unorganized institution that centered upon the personality of Titchener, who stimulated its attendants with his grace and wisdom and sometimes vexed them with his insistent punctiliousness. The group never had a by-law, and its name, Experimental Psychologists, came to be fixed upon the group by usage without formal fiat. Except for one year during the war (1918), the meeting of Experimental Psychologists occurred annually in the spring from 1904 until 1928, the year after Titchener's death when formal organization was undertaken. The group had no officers. There was a "host," who invited laboratories in the persons of their heads, and each head brought along members of his staff and some of his more advanced graduate students. At the first four meetings papers were read, actually and even "by title," and also at some of the later meetings as in 1912. There grew up gradually, however, the custom that the guests should participate by informal communication and report. No abstracts of their remarks were published after 1907. Few formal papers were read after 1912. It was usual to report work in progress, to discuss difficulties and to ask for help. The older men found the frank and friendly atmosphere of the meetings pleasant and helpful, while the younger men were stimulated by this intimate view of persons who had seemed to them remote and important. This is the positive side of the picture.

On the negative side there were the difficulties created by Titchener's insistent regnancy. Always Titchener dominated the group. There was the recurrent question as to who was to be invited. Invitations were supposed to be by laboratories, but personalities in their relation to Titchener played an important rôle. Each host consulted as to his guests with Titchener, who was virtually the arbiter of invitations. Not only were there certain persons in certain years who were understood to be ostracized from Titchener's presence; there were also those whose status as experimentalists lay in doubt. Practically up to the time of Titchener's death *experimental psychology*, in this group, meant generalized, human, adult, normal, experimental psychology. It was easy to exclude the mental testers, but animal psychology was always slipping in. Yerkes, for instance, came occasionally and usually kept silence in the field of his own expertness. Representation by laboratories also caused minor

[1] This history is written at the mandate of the Society of Experimental Psychologists at its meeting at Smith College in the spring of 1937. The chairman appointed, as a Committee on History, S. W. Fernberger, chairman, K. M. Dallenbach, H. S. Langfeld, W. R. Miles and myself; and my colleagues made me the historian. These colleagues, my older associates in the present membership of the Society, and some of Titchener's old group have aided me by reminiscence, correspondence, and review of my paragraphs.

difficulties, for Titchener never came around to the American view that there could be two leading psychologists in the same laboratory. Who was the "head" when Angier, Dodge and Yerkes turned up together at Yale, when Boring joined Langfeld and McDougall at Harvard, or when Langfeld joined Warren at Princeton? And was not Cattell the head at Columbia? But Titchener stood firm on his two kinds of qualifications for the guests: certain social proprieties and the meaning of the term *experimental*. In consequence most of the memories that still persist about these meetings of Experimental Psychologists in 1904-1927 are anecdotes which gain their points from the personal relations of everyone else to the focal personality of Titchener.

The first meeting was at Cornell on April 4–5, 1904.[2] The invitations were by laboratories, and it is certain that the following laboratories were represented: (1) Cornell by Titchener, who was host and founder, and Madison Bentley (assistant professor), G. M. Whipple (lecturer on education), J. W. Baird (Carnegie research assistant), H. C. Stevens and C. E. Ferree (assistants in the laboratory) and G. H. Sabine (a graduate student of philosophy); (2) Yale by C. H. Judd, who was very active in the discussion and wrote up the meeting; (3) Pennsylvania by Lightner Witmer, who was also active; (4) Clark by E. C. Sanford, who reported experiments of his own, although not of other members of the Clark laboratory; (5) Michigan by W. B. Pillsbury, who brought C. E. Galloway along with him; and (6) Princeton by H. C. Warren, left in charge at Princeton by Baldwin's recent move to Hopkins.

Some of us remember that Titchener at the Cornell meeting in 1923 reviewed the history of the Experimental Psychologists, and showed on a chart that ten laboratories had been represented at the first meeting. It now seems probable that this memory is wrong or that the chart was wrong. It seems clear that Columbia, Harvard and Hopkins were not represented in 1904. C. E. Seashore had been asked for Iowa and sent a paper which Baird read. J. R. Angell had been asked for Chicago and introduced Matilde Castro, whose paper was "read by title." From the first the group—especially Titchener—was opposed to the presence of women at its meetings, and Miss Castro was not there. It may have been that Titchener invited ten laboratories whose heads indicated their willingness to support the new meetings, although only six (or seven) actually came, while at least two more (Chicago and Iowa) made the gesture of membership by sending papers.

Judd in writing up the account of this meeting listed thirteen papers that were actually read: three by himself, two each by Witmer and Whipple, and one each by Sanford, Pillsbury and several of the younger men. Six papers were read by title, including two by Titchener, who seems as host to have refrained from displacing others on the program. That Titchener wanted from the start to have the meetings informal is shown by the fact that he suggested calling the group the Fechner Club, a suggestion which, however, met with little approval.

The second meeting was at Clark with Sanford as host, on March 31 and April 1, 1905.[3] Münsterberg had sent an invitation from Harvard to the previous meeting, but probably it was decided to go to the laboratory of someone who had actually been present at the first meeting. Moreover, Titchener was especially close to Sanford

[2] C. H. Judd, Meeting of Experimental Psychologists at Cornell University, *J. Philos.*, 1, 1904, 238-240.

[3] Unsigned note on the Clark meeting with no title, *J. Philos.*, 2, 1905, 223.

and to Clark. The published note shows that, besides Sanford and Titchener, L. M. Terman and Arnold Gesell were there from Clark, Bentley and Stevens from Cornell, A. H. Pierce from Smith, and J. P. Hylan from Harvard. Witmer and F. M. Urban were there from Pennsylvania, and presumably Judd from Yale. Baldwin was there from Hopkins. It is not at all clear about Münsterberg. Stevens read a paper sent by Max Meyer from Missouri. President G. Stanley Hall, who no longer claimed to be an experimental psychologist, entertained the group and also gave an address on "Tendencies and Dangers in Experimental Psychology." We may guess what was said by the man whose later advice to psychologists was: "Build the top of the mountain first!" Titchener led the discussion of Hall's views. A. G. Webster, Clark's distinguished physicist and acoustician, demonstrated apparatus for the measurement of the absolute intensity of tone. The brief unsigned published note about the meeting shows that the counsel of intimate informality was beginning to prevail.

The third meeting was at Yale under Judd in the spring of 1906. There was no published note and reminiscences are few. The meeting was small and held in Judd's study. It was Raymond Dodge's first meeting, and he recalls his surprise that Judd disputed with the great Titchener with such freedom. Titchener was thirty-nine and Judd was thirty-three, but Titchener usually managed to add about ten years to his prestige. R. S. Woodworth was there, and he recalls making a report on his introspective study of the antecedents of voluntary movement and being commended for it by Titchener. At this meeting Titchener insisted that there be no published note, and there was none.

Witmer had the fourth meeting at Pennsylvania in 1907.[4] The resolve against publicity lapsed, and Baird published a five-page note, containing abstracts of sixteen papers read by fourteen persons. E. B. Twitmyer, Urban, and J. D. Heilman participated for Pennsylvania; Titchener, Ferree, L. R. Geissler and W. H. Pyle for Cornell; Sanford for Clark; Baird for Illinois; J. H. Leuba for Bryn Mawr; and H. H. Goddard for the Vineland Training School. Baird read a paper of S. S. Colvin's representing work of Colvin's at Illinois. A novel feature was a round table discussion of plans and methods for instruction in psychology. Urban's paper was on "The Method of Just Perceptible Differences." The paper was long and difficult and Urban was feeling discouraged about his work, but Titchener broke a silence to pronounce it epoch-making in the history of psychophysics, and thus to gain Urban's lasting appreciation and gratitude. This must also be the meeting at which Witmer jocularly referred to Titchener as "the king of the meeting," thus invoking Titchener's anger.

In 1908 the meeting went to Harvard.[5] Hugo Münsterberg was in charge, assisted by E. B. Holt and R. M. Yerkes. The brief note that was printed about the meeting recognizes the fact that the representation was by laboratories rather than by persons. It lists as present fourteen laboratories, and gives the names of the eighteen persons representing them in parentheses afterward: Brown (E. B. Delabarre), Bryn Mawr (Ferree), Clark (Sanford and J. P. Porter), Columbia (J. McK. Cattell and E. L. Thorndike), Cornell (Titchener), Hopkins (J. M. Baldwin), McLean Hospital

[4] J. W. Baird, The proceedings of the Philadelphia meeting of Experimental Psychologists, this JOURNAL, 18, 1907, 383-388.

[5] Unsigned note, Fifth annual meeting of Experimental Psychologists, this JOURNAL, 19, 1908, 288.

(F. L. Wells), New York University (J. E. Lough), Pennsylvania (Urban), Princeton (Warren and C. L. Vaughan), Smith (A. H. Pierce), Wesleyan (Dodge), Wisconsin[6] (Daniel Starch), Yale (R. P. Angier and E. H. Cameron). The representation seems to have been much more general than at any previous meeting. All the important laboratories and nearly all the important men from the East were there.[7] Judd had gone to Chicago, and Witmer was absent, but Baldwin, Cattell and Thorndike were there. Münsterberg had the gift of showmanship. He organized this more representative convocation, staging the exhibition in the new psychological laboratory in Emerson Hall. It was in the account of this meeting that the participation of the members was referred to as "communications" and not as "papers." In later years read papers were discountenanced, and ultimately all reports were informal and ostensibly *ex tempore,* although Titchener at least was known to drill his graduate students in advance for their oral presentation of the results of their experiments. Still the practice varied. In 1911 there were no read papers; in 1912 all the reports were read.

In 1909 the meeting went to Warren at Princeton.[8] There were said to have been twenty-three psychologists in attendance, but only the names of a few who gave formal communications were listed. Knight Dunlap was there from Hopkins. The other names were not new to the group. No anecdotes seem to have survived from this meeting.

J. B. Watson was host at Hopkins in 1910. There was no printed report of the meeting. He recalls the presence of Titchener, Holt, Yerkes, Baird, H. S. Langfeld and H. M. Johnson. It was the first meeting for Langfeld and Johnson, as well as for Watson. Holt and Yerkes called each other by their first names, and Titchener was distressed by such unBritish conduct.

The eighth meeting in 1911 went back again to Titchener at Cornell. It was my first meeting. Just as Dodge five years before had been impressed by the temerity with which Judd stood up to Titchener, so here I was astonished at the way in which Dodge and Holt argued against Titchener on the matter of introspection—especially Holt, who was so caustic and dramatic that he had later to explain to me, as I took him to the trolley, how great was his real underlying admiration for Titchener. There were no published notes about the meetings from 1910 to 1912 inclusive.

In 1912 there was a second Clark meeting, this time under Baird, for Sanford, as the new President of Clark College, had withdrawn from active work in experimental psychology. Besides the usual attendants, Thorndike was there to represent Columbia, and he and Titchener led in a symposium on imageless thought. The meeting was the first for K. M. Dallenbach and H. P. Weld. Dallenbach played

[6] The published note prints *Wellesley* but must mean *Wisconsin,* for Starch was never at Wellesley, the Wellesley psychologists (M. W. Calkins and E. A. McC. Gamble) were women and not welcome, and the laboratory is listed in a position alphabetically correct for *Wisconsin* and not for *Wellesley.*

[7] In 1908 the American Psychological Association had 209 members, less than a tenth of its present membership, and they represented instruction in sixty-two colleges and universities. In other words, Münsterberg gathered together at Harvard about one-tenth of the membership of the American Psychological Association. Today a group of eighteen would be less than one percentage.

[8] Unsigned note, The sixth annual meeting of Experimental Psychologists, this JOURNAL, 20, 1909, 471.

blindfold chess and introspected upon the process to show the dominant rôle of kinesthesis in his playing.[9]

The tenth meeting in 1913 with Dodge at Wesleyan was an anniversary meeting.[10] The heads of the larger laboratories undertook to summarize the researches of their laboratories during the decade of the society's existence. In all there were about twelve laboratories represented. Dodge arranged to have Wells and Goddard discuss mental tests, "their theory, value and limitation," and the discussion seems to have been lively and somewhat opposed to the use of the word *test*. There was a more lively discussion of Watson's new school of behaviorism and a seemingly unanimous dissent from his views; but Watson was not there. Münsterberg was there; Dodge arranged for him to give a semi-public lecture on the mind-reading of Beulah Miller. The introduction of Münsterberg, mind-reading, tests and behaviorism into the usually circumscribed sphere of these meetings was consistent with Dodge's chairmanship, for he always exerted his influence toward catholicity of interests against Titchener's support of rigid specificity.

Columbia, like Hopkins, had been represented somewhat sporadically in the group. The interests of Cattell and Titchener diverged widely. Cattell said, for instance, that, since he could not trust his own introspection, he was dubious of anyone's else. Moreover, attendance at the spring meeting was difficult because Columbia had no vacation at that time. Nevertheless Cattell, Thorndike and Woodworth went to the meetings at times, and in 1914 Columbia was host. Cattell presided, though Woodworth made the arrangements. Cattell introduced the plan of having reports of research made by subject-matter, according to the classification of the *Psychological Index*, instead of by laboratories, thus dislocating slightly one of the traditions of the group. It was at this meeting that Christine Ladd-Franklin, always militant in behalf of her color theory and the rights of women, almost invaded the masculine sessions. She did come to one session, but tradition was kept supreme at the others. Between sessions she captured psychologists to have them view her demonstration of simple and complex colors, an exhibit which she thought proved Titchener wrong on the controversial issue of the simplicity of all hues. This meeting was the first for A. T. Poffenberger and W. R. Miles.

In 1915 the meeting was at Yale with Angier as host. K. S. Lashley was present. In 1916 the sessions were at Princeton with Warren as host. A photograph taken at the Princeton meeting shows thirty-two psychologists. The group was growing. There are after 1913 no further printed notes about these meetings until the formal organization of the Society of Experimental Psychologists after Titchener's death.

The 1917 meeting at Harvard occurred shortly after Münsterberg's death, in the specific excitement caused by Titchener's call to succeed Münsterberg (but he did not go), and the general excitement caused by the United States' declaration of war against Germany. Langfeld was the official host for he had just been made acting Director of the Harvard Laboratory, but Yerkes and Holt shared the responsibilities with him. At the final session on April 6, the day of America's declaration of war, the group turned to the consideration of what American psychologists could do to

[9] K. M. Dallenbach, Blindfold chess: the single game, *Studies in Psychology* (Titchener Commemorative Volume), 1917, 214-230.

[10] S. W. Fernberger, Convention of Experimental Psychologists, this JOURNAL, 24, 1913, 445.

assist the Government in the war.[11] Yerkes, who was then president of the American Psychological Association, took the chair. Titchener, as a British subject, withdrew to the periphery of the group. Captain W. S. Bowen, instructor in military science at Harvard, was brought in for advice. The problem of the selection of men for a great army and of the elimination of the feeble-minded was considered. Finally a committee, under Yerkes' chairmanship, was appointed "to gather information concerning the possible relations of psychology to military problems." It was this small stone that began the avalanche of intelligence testing in the United States Army, although it must be said that the stone required many other pushes before it could roll alone.

The war prevented any meeting in 1918. In 1919 Titchener had a small group at Cornell, some of them still in uniform. In 1920 they went to Cornell again for a larger meeting, and then in 1921, they went to Boring at Clark, for Baird had died in 1919.

In 1922 Dodge was host at Wesleyan. This was the year in which a breach between Woodworth and Titchener was healed. In 1920 Woodworth, finding that he could not attend the meeting at Cornell, had posted Titchener's card of invitation on the laboratory's bulletin board, with the added query: "Who can go?" One of the juniors did go, but Woodworth's action seemed to Titchener to indicate so great a misunderstanding of the personal character of the invitation to the meetings that it became a question as to whether Columbia was still a member of the group. In 1922 Dodge determined to correct this situation. Woodworth appeared, and Titchener, well prepared for the critical moment, greeted him with all necessary cordiality. It was also at this meeting that Dallenbach acquired adaptation to rotation on Dodge's beautiful apparatus and then willfully raised his head, proving that the relation of the stomach to the semi-circular canals is not one of psychology's fictions.

The nineteenth meeting in 1923 was again at Cornell, and Titchener treated it as a second decennial occasion, for the first decenary had been celebrated in 1913. Titchener reviewed the history of the society.

In 1924 the meeting was again at Clark. Sanford, having retired from the presidency of Clark College, was again back in experimental psychology, and he was host. Boring had left, and J. P. Nafe was not to come until the next year. Titchener, having insisted on coming by automobile from Ithaca, was blocked by a snow drift near Albany, and his junior colleagues had to shovel him through. He was late, but not too late to make, on behalf of the group, the presentation of a clock to Sanford to mark his retirement from teaching. Sanford retired in June and died in November.

The 1925 meeting went to Warren at Princeton. The session was in part a dedication of Eno Hall, the new Princeton Laboratory. Titchener delivered a formal address, a retrospect of experiment psychology.[12] Wolfgang Köhler and Kurt Koffka were in America, emissaries of the Gestalt movement, and they attended as guests. The meetings were, however, getting unwieldy. The picture of the group at this meeting shows forty persons.

In 1926 Fernberger had the meeting at Pennsylvania. In 1927 Boring had it at Harvard. This meeting was much too large. Thirty-eight men came from twelve

[11] R. M. Yerkes, Psychological examining in the United States Army, *Mem. Nat. Acad. Sci.*, 15, 1921, 7.

[12] E. B. Titchener, Experimental psychology: a retrospect, this JOURNAL, 36, 1925, 313-323.

laboratories: Clark (7), Princeton (6), Yale (6), Cornell (5), Columbia (3), Wittenberg (3), Hobart (2), Wesleyan (2), Pennsylvania (1), Smith (1), Stanford (1), Wellesley (1). Boring selected seven members of the Harvard staff, and thirteen of the experimentalists among the graduate students. That made fifty-eight in all, and Titchener had always complained that Harvard brought a maximum of men and a minimum of research to the meetings! There is a strip of moving pictures of some of the men at this meeting. Titchener's beard looks quite white.

And then in August Titchener died.

The twenty-fourth meeting, the last meeting of the unorganized group that had accepted Titchener's will instead of by-laws, was held at Yale in 1928 with Dodge

TABLE I

MEETINGS

(The meetings have been held every spring since 1904, except 1918, the year of the War.)

Informal Meetings

Place	Year	Host	Place	Year	Host
1. Cornell	1904	Titchener	13. Princeton	1916	Warren
2. Clark	1905	Sanford	14. Harvard	1917	Langfeld
3. Yale	1906	Judd	15. Cornell	1919	Titchener
4. Pennsylvania	1907	Witmer	16. Cornell	1920	Titchener
5. Harvard	1908	Münsterberg	17. Clark	1921	Boring
6. Princeton	1909	Warren	18. Wesleyan	1922	Dodge
7. Hopkins	1910	Watson	19. Cornell	1923	Titchener
8. Cornell	1911	Titchener	20. Clark	1924	Sanford
9. Clark	1912	Baird	21. Princeton	1925	Warren
10. Wesleyan	1913	Dodge	22. Pennsylvania	1926	Fernberger
11. Columbia	1914	Cattell	23. Harvard	1927	Boring
12. Yale	1915	Angier	24. Yale	1928	Dodge

Formal Organization

Place	Year	Chairman	Place	Year	Chairman
25. Princeton	1929	Warren	30. Harvard	1934	Boring
26. Cornell	1930	Bentley	31. Yale	1935	Miles
27. Vassar	1931	Washburn	32. Clark	1936	Hunter
28. Columbia	1932	Woodworth	33. Smith	1937	Koffka
29. Pennsylvania	1933	Fernberger	34. North Carolina	1938	Dashiell

as host. It too was a large meeting. Nineteen of the older men at dinner decided that the tradition could not be continued without radical change. They appointed a committee (Warren, chairman, Boring, Dodge, Langfeld, Yerkes) to plan a society to carry on the tradition of experimentalism with such organization and changes as should be necessary to insure smoother working of the group in the future, and they instructed Dodge to refuse the invitations that had been tendered for the following year and to announce that the meetings of the past would not be continued.

THE FORMAL ORGANIZATION

The function of the Committee of Five of 1928 was to enlarge itself into a representative committee which could adopt principles and a form of organization and then enlarge itself still more. The Committee of Five, however, had also to consider principles lest it start growing in the wrong direction. Certain principles

had been established at the dinner. (a) There was to be a simple form of organization and a determinate membership, so that there should be no longer uncertainty and disagreement about invitation lists. (b) The meetings were to be kept small, considerably smaller than some of the recent meetings that had had an attendance of more than fifty, and the size was to be controlled by excluding younger men—graduate students and perhaps instructors. (c) Animal psychology was to be admitted as experimental psychology, and Yerkes' inclusion in the Committee of Five was intended to settle this point. Everyone was ready to change from Titchener's immutable conservatism, which held that experimental psychology is only a psychology of consciousness.

On the other hand, there were some questions not yet settled. The most important of these was (d) the issue between the academy plan and the club idea. Dallenbach was supporting a plan for an American academy of experimental psychology, an honor society of the older experimentalists, limited to about fifty persons, holding small meetings for discussion and mutual aid, and competent to become a stimulus to younger men. Since an academy would be national in scope, its meetings would be less representative than those of a more local society. Opposed to the academy idea, there was the conception of a small eastern group, chosen for the purpose of meeting for discussion and mutual aid, a group including younger men and excluding inharmonious personalities; in other words, a club. Of course, the Committee of Five could not undertake to settle the issue of academy *vs.* club.

In enlarging itself the Committee of Five had to consider other problems. (e) Should it elect psychologists not in the east? If it elected men from the west, it had prejudged the issue in favor of an academy. If it elected only men in the east, it had not got a representative group. Actually it dealt with this matter inconsistently, for it first decided not to prejudice the club-academy issue, and then later elected Bott to represent Canada, Miles the west, Bentley the middle west, and Peterson the south. (f) Should it elect women? That would be another break with the tradition of the past. It decided not to prejudice this issue and thus did not elect Miss Washburn or Miss Downey, both of whom were discussed favorably. (g) Should it define experimental psychology to include the tests, educational psychology and abnormal psychology? It decided against this extension for the time being, leaving the matter to the future. (h) Although the question of compatibility of personalities was discussed, as well it might be after the long years with Titchener, the matter did not become a factor in any judgment. It appeared that all the important experimental psychologists in the limited field thus far defined were now sufficiently congenial to go profitably to the same meeting. Something had changed.

The Committee of Five next undertook to make out a list of distinguished experimental psychologists, excluding the men of the tests, educational psychology and abnormal psychology, but including all others in the United States and Canada. It wanted men who might be in an academy if an academy were formed, and it was surprised when it was unable to find more than thirty-two plausible names for such a list. It suddenly became clear that Dallenbach's academy of fifty could not even be filled at once. The committee voted on this list, and chose the ten persons who received a unanimous vote to add to its number. The result was a Committee of Fifteen, an "organizing nucleus" which could meet in 1929, effect a permanent organization and elect other members. The Committee of Fifteen was:

Bentley (*Illinois*)	Fernberger (*Pennsylvania*)	Peterson (*Peabody*)
Boring (*Harvard*)	Hunter (*Clark*)	Robinson (*Yale*)
Bott (*Toronto*)	Lashley (*Inst. Juv. Res.*)	Warren (*Princeton*)
Dallenbach (*Cornell*)	Langfeld (*Princeton*)	Woodworth (*Columbia*)
Dodge (*Yale*)	Miles (*Stanford*)	Yerkes (*Yale*)

These fifteen men were invited by Warren to Princeton in 1929 for a "quiet meeting" to affect a permanent organization and also to discuss experimental psychology. This meeting is regarded by some as the prenatal meeting of a new society, by others as the first meeting of the new society, and by still others as the twenty-fifth meeting of the Experimental Psychologists. Your historian takes this last view because the continuity of the Society, in spirit, purpose and accomplishment, is clear from 1904 until the present.

Ten of the fifteen members of the "organizing nucleus" were present at this Princeton meeting: Bentley, Dallenbach, Dodge, Fernberger, Langfeld, Miles, Peterson, Robinson, Warren, Yerkes. This group decided (a) that it would organize a society of experimental psychologists for the purpose of informal discussion, (b) that the membership of the society should be limited to North American experimental psychologists, (c) that there should be no other regional limitation upon membership, (d) that there should be no restriction of membership with regard to sex, and (e) that there should be no restriction with regard to organism studied.

The meeting then adopted the by-laws which are printed at the end of this article. It will be seen that, in adopting these by-laws, the committee chose the academy plan. Dallenbach had worked out a set of by-laws which he distributed at the meeting, and to a very great extent his views prevailed. Thus the Society of Experimental Psychologists limited itself to fifty members with the intention that election should become a distinctive honor conferred upon a new member. The provision that election at the annual meeting should be by roll-call and unanimous was Dallenbach's idea. Altogether it has worked quite well, since one objector will seldom persist long in obstructing an election that is wanted by all the other members present, and it is probable that the full discussion associated with a roll-call results in better judgments than would a high percentage on a secret ballot.

This Committee first elected to the Society the fifteen persons of the "organizing nucleus." It then elected eleven more persons:

Brown (*California*)	Dunlap (*Hopkins*)	Stone (*Stanford*)
Carr (*Chicago*)	Johnson (*Pittsburgh*)	Washburn (*Vassar*)
Cobb (*Nela Park*)	Koffka (*Smith*)	Weld (*Cornell*)
Downey (*Wyoming*)	Seashore (*Iowa*)	

That made twenty-six members in all, and, if the term "charter member" were to be used, it should be applied to these twenty-six, since they are the first fully representative group to come into function in the new organization. Washburn, for instance, would certainly have been elected in 1928 if there had not been the question about women, and others also would have been elected then had the principles for election become clear.

Fernberger was elected secretary of the Society at this meeting and has continued in this post until the present time. The Chairman, who takes the place of the "host" in the Titchener days, is elected annually as a senior man at the institution at which the Society will meet. He has few administrative functions except at the meeting.

In general, it may be said that the adoption of the academy idea has not interfered with the free and informal discussion that was the genius of the Titchenerian era. The meetings are well attended and are growing as the membership grows. Elections are hotly contested, but there are a few successful nominees every year. The younger men join in discussion with the older and titles are dropped between members. There are never any papers. The chairman calls upon members in turn and each limits himself to the report of one or two problems. Reports are *ex tempore*. Published articles are not reported. Research in progress is frequently reported, and criticism of it sometimes leads to an alteration of procedure. Members bring in problems about research in progress or research not yet begun, and ask for assistance, and get it. The sessions are kept short as Titchener always had them: a morning, an afternoon, an evening, another morning, and another afternoon. Members go away tired but stimulated.

TABLE II

MEMBERSHIP AND ATTENDANCE

(The figures for members, attendance and Fellows show the status of the Society at the beginning of each annual meeting before any new members had been elected or were in attendance.)

Year	Place	Attendance	Total members	Total Fellows	Elected at meeting	Deaths during year
1929	Princeton	10	0	0	26	0
1930	Cornell	16	26	0	3	0
1931	Vassar	15	28	1	5	0
1932	Columbia	19	33	1	3	0
1933	Pennsylvania	18	34	1	3	1
1934	Harvard	18	36	1	3	2
1935	Yale	20	38	2	1	0
1936	Clark	20	36	4	6	1
1937	Smith	25	40	5	4	1
1938	North Carolina	—	43	6	—	—
				Total.....	54	5

Table II shows the attendance and the membership of the Society in successive years. A member becomes a Fellow automatically on his sixty-fifth birthday, thus also creating an additional vacancy in the membership, which is limited to a total of fifty. Thus far there have been seven Fellows in the Society (Table III). There have been five deaths (Table III). Altogether fifty-four persons have been elected to the Society. In 1937 the Society had reached a total of forty-three members and six Fellows (Table II). The annual elections of members up to 1937 are shown in Table III. The attendance has increased in numbers from sixteen to twenty-five, but the relative attendance has remained constant at a little more than half the total number of members and Fellows (Table II).[18]

In general it appears that the Society draws its membership from about half the membership of the American Psychological Association, since the Society excludes certain fields from consideration. Within this half of the American psychologists,

[18] The meetings from the 26th at Cornell in 1930 to the 33rd at Smith in 1937 have been reported by K. M. Dallenbach in this JOURNAL: 42, 1930, 469; 43, 1931, 525; 44, 1932, 582; 45, 1933, 539; 46, 1934, 511 (this report was by Fernberger); 47, 1935, 344; 48, 1936, 526; 49, 1937, 487.

TABLE III

ELECTIONS

(Membership by year of election. The institution cited shows the location of the member at the time of his election.)

1. *Elected in 1929:*
   - Madison Bentley, *Cornell;* Fellow, 1935-
   - Edwin G. Boring, *Harvard*
   - Edward A. Bott, *Toronto*
   - Warner Brown, *California*
   - Harvey A. Carr, *Chicago*
   - Percy W. Cobb, *Nela Park*
   - Karl M. Dallenbach, *Cornell*
   - Raymond Dodge, *Yale;* Fellow, 1936-
   - June E. Downey, *Wyoming;* died, 1932
   - Knight Dunlap, *Hopkins*
   - Samuel W. Fernberger, *Pennsylvania*
   - Walter S. Hunter, *Clark*
   - Harry M. Johnson, *Mellon Institute*
   - Kurt Koffka, *Smith*
   - Herbert S. Langfeld, *Princeton*
   - Karl S. Lashley, *Inst. Juv. Res.*
   - Walter Miles, *Stanford*
   - Joseph Peterson, *George Peabody;* died, 1935
   - Edward S. Robinson, *Yale;* died, 1937
   - Carl E. Seashore, *Iowa;* Fellow, 1931-
   - Calvin P. Stone, *Stanford*
   - Howard C. Warren, *Princeton;* Fellow, 1932-34; died, 1934
   - Margaret F. Washburn, *Vassar;* Fellow, 1936-
   - Harry P. Weld, *Cornell*
   - Robert S. Woodworth, *Columbia;* Fellow, 1934-
   - Robert S. Yerkes, *Yale*

2. *Elected in 1930:*
   - John F. Dashiell, *North Carolina*
   - Albert T. Poffenberger, *Columbia*
   - Edward C. Tolman, *California*

3. *Elected in 1931:*
   - Leonard Carmichael, *Brown*
   - Elmer Culler, *Illinois*
   - Shepherd I. Franz, *California in Los Angeles;* died, 1933
   - Walter B. Pillsbury, *Michigan;* Fellow, 1937-
   - John F. Shepard, *Michigan*

4. *Elected in 1932:*
   - Harry L. Hollingworth, *Columbia*
   - Clark L. Hull, *Yale*
   - Ernest G. Wever, *Princeton*

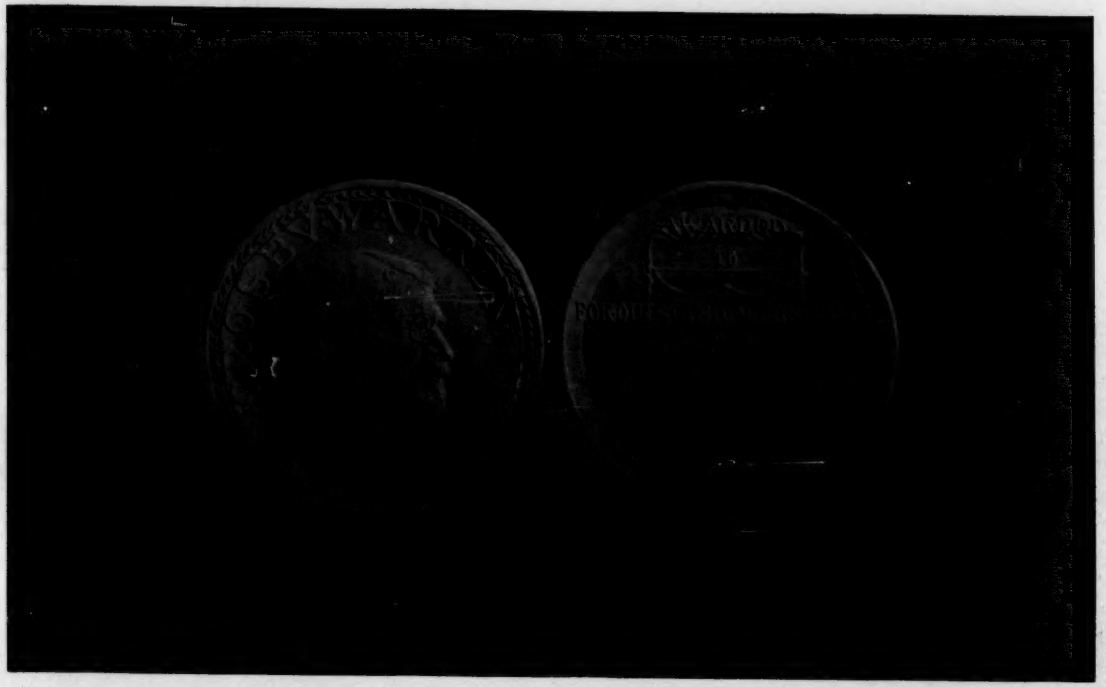
5. *Elected in 1933:*
   - John G. Beebe-Center, *Harvard*
   - Heinrich Klüver, *Inst. Juv. Res.*
   - Herbert Woodrow, *Illinois*

6. *Elected in 1934:*
   - Carney Landis, *Columbia*
   - John A. McGeoch, *Missouri*
   - Carroll C. Pratt, *Harvard*

7. *Elected in 1935:*
   - John P. Nafe, *Washington University*

8. *Elected in 1936:*
   - Charles W. Bray, *Princeton*
   - Clarence H. Graham, *Clark*
   - Ernest R. Hilgard, *Stanford*
   - Carlyle Jacobsen, *Yale*
   - Wolfgang Köhler, *Swarthmore*
   - Max Wertheimer, *New School Soc. Res.*

9. *Elected in 1937:*
   - Joy P. Guilford, *Nebraska*
   - Lyle H. Lanier, *Vanderbilt*
   - Donald G. Marquis, *Yale*
   - Harold Schlosberg, *Brown*



THE HOWARD CROSBY WARREN MEDAL

election to the Society appears to be implicative of distinction as indicated by other measures of eminence.

There had sometimes been talk of prizes in experimental psychology. Titchener and Urban, with William Brown, had once been a committee of award for a prize in psychophysics, a prize which was awarded in 1920 to Dr. Godfrey H. Thomson.[14] In 1931 Dallenbach wanted the Society of Experimental Psychologists to establish a prize for experimental research, and Warren supported him, but the matter was tabled. Then in 1934, shortly after Warren's death, Dallenbach suggested to Mrs. Warren that she might found a memorial medal in honor of her husband. Mrs. Warren welcomed the idea, and, after the Society had indicated its support by a mail ballot, it adopted at the Yale meeting in 1935 a plan whereby the Howard Crosby Warren Medal could be awarded annually, on decision of a standing Medal Committee of three, "for outstanding work in experimental psychology in the United States or Canada published during the five years preceding the time of the award." (For the obverse and reverse of the Warren Medal, see the accompanying Plate.) While the legal arrangements for the final acceptance of the gift were not completed until 1937, Mrs. Warren made possible the award in 1936. This award was to Wever and Bray of Princeton. The second award in 1937 was to Lashley of Harvard, and the third in 1938 was to Culler of Illinois. (See Table IV for the citations.) The Medal Committee has had the following personnel: 1936—Woodworth, Dallenbach, Carmichael; 1937—Dallenbach, Carmichael, Poffenberger; 1938—Carmichael, Poffenberger, Boring.

TABLE IV

Warren Medalists

1. In 1936, Ernest Glen Wever and Charles William Bray, of Princeton University, for their studies of auditory nerve responses in reptiles and insects, following up their similar work on mammals, the whole research constituting an outstanding contribution to the study of auditory function.
2. In 1937, Karl Spencer Lashley, of Harvard University, for his distinguished work on the physiological basis of learning and on the neural mechanisms involved in vision.
3. In 1938, Elmer Culler, of the University of Illinois, for his work on the fundamental mechanisms of hearing and on the physiological basis of the conditioned reflex.

The acceptance of Mrs. Warren's endowment of the Warren Medal required that the Society incorporate. Accordingly, in 1936, a committee (Langfeld, Wever and Fernberger) incorporated the Society in the state of New Jersey. At the 1937 meeting Bray, Fernberger and Wever were elected trustees of the Corporation for one year. There is, however, no sign as yet that the Society of Experimental Psychologists, Inc., is likely to be any more formal, any more structured, any more constitution-ridden than the original group of Experimental Psychologists that Titchener brought together.

Harvard University Edwin G. Boring

[14] Unsigned announcement of a prize of $100 in psychophysics, this Journal, 25, 1914, 148; cf. also notes by E. B. Titchener, *ibid.*, 26, 1915, 620; 31, 1920, 100.

BY-LAWS OF THE SOCIETY OF EXPERIMENTAL PSYCHOLOGISTS

ARTICLE I: NAME

The organization shall be known as the Society of Experimental Psychologists.

ARTICLE II: OBJECT

The object of the Society shall be to advance psychology by arranging informal conferences on experimental methodology.

ARTICLE III: MEMBERSHIP

Section 1. The Society shall consist of members and fellows.

Section 2. Membership in the Society shall be limited to persons who are engaged in the advancement of experimental psychology.

Section 3. The number of members shall not at any one time exceed fifty (50).

Section 4. A member who has reached the age of sixty-five (65) years shall automatically become a fellow.

Section 5. Fellows shall have all the rights and privileges of members except the privilege of voting for new members.

Section 6. A member who takes up permanent residence outside of the North American continent shall automatically be dropped from the Society.

ARTICLE IV: ELECTION OF MEMBERS

Section 1. Nominations for membership may be made by any member or fellow.

Section 2. After discussion of the candidate's qualifications, the nature and character of his experimental work and such other information as may assist the members in judging his fitness for membership in the Society, a vote by roll call of the members present shall be taken.

Section 3. A candidate shall be declared elected to the Society on the unanimous vote of the members present and voting at any business meeting. A quorum for this purpose shall consist of one-third of the membership.

ARTICLE V: OFFICERS

Section 1. The officers of the Society shall be a Chairman and a Secretary-Treasurer.

Section 2. The term of office shall be one year for the Chairman and three years for the Secretary-Treasurer.

Section 3. In case of a vacancy the most recent chairman shall have direction of a mail vote to fill the vacancy.

Section 4. The Chairman shall ordinarily be chosen from among the members resident at the prospective place of meeting.

ARTICLE VI: MEETINGS

Section 1. The annual meeting of the Society shall ordinarily be held during the spring at a time designated by the Chairman.

Section 2. The Chairman may invite a limited number of investigators in experimental psychology from the institution entertaining the Society to attend the scientific discussions as auditors.

ARTICLE VII: DUES

The annual dues of members shall be one dollar ($1).

ARTICLE VIII: AMENDMENTS

These By-Laws may be amended at any time by a three-fourths vote of all the members of the Society.

STANDING VOTES AND RULINGS

Nominations by mail. The Secretary shall issue a call for nominations of new members at least ninety days before the annual meeting. At least forty days before the annual meeting he shall send the list of all names suggested to all members of the Society with the request that each member second or offer objection to all names in which he is interested. Only those names which, five days before the annual meeting, shall have received at least one second and not more than two objections shall be presented to the annual meeting for consideration. (Voted unanimously, March 24, 1932.)

Quorum for election. The last sentence of Article IV, Section 3, of the By-Laws, which reads, "A quorum for this purpose shall consist of one-third of the membership," must be interpreted to mean that this ratio of the members must vote positively for any candidate. (Ruling by Chair, sustained by vote of meeting, March 24, 1932.)

Electoral votes not cast by mail. Nominations, seconds and objections, expressed to the Secretary by mail, shall apply only to the question of the presentation of the names to the meeting and are not to be considered in the balloting at the meeting. (Ruling by Chair, sustained by vote of meeting, April 3, 1934.)

Mail votes on matters of policy. It is the sense of the meeting that matters of fundamental policy should be referred by the annual meeting to the entire membership, with indication of discussion during the meeting, and further that mail votes should be authorized only by the vote of an annual meeting or by a mail vote. (Voted, April 4, 1935.)

Award of the Warren Medal. (1) The Warren Medal shall be awarded annually, unless no suitable contribution shall have appeared, for outstanding work in experimental psychology in the United States or Canada, published during the five years preceding the time of the award.

(2) The award shall be determined as follows:

(a) A standing Medal Committee of three shall be appointed by the outgoing Chairman of the Society, whose terms of office shall be staggered so that one member retires every year. The senior member shall serve as the Committee chairman.

(b) The duties of this Committee shall be:

(i) In November of every year the Committee shall request the members of the Society, through the Secretary, to suggest studies that are in their opinion worthy of the award.

(ii) The Committee shall review the suggested studies and select the one that it regards as the most worthy.

(iii) The results of the award, which shall be final, shall be reported to the Chairman of the Society, who shall invite the recipient or recipients of the award to attend the annual meeting of the Society to be presented with the Medal.

(c) Studies written or directed by members of the Medal Committee are not eligible for consideration. (Voted, April 4, 1935.)

Medalists need not be members. It is the sense of the Society that the award of the Warren Medal does not commit the Society to the election of the recipient to membership in the Society. (Voted, April 9, 1936.)

A Critical Examination of Nafe's Theory of Thermal Sensitivity

According to Nafe, *vascular activity* is the basis for all thermal experience and there is no need to postulate specific warm and cold receptors. Warmth is simply the kinesthetic pattern from dilating blood vessels. Cold arises, similarly, from vasoconstriction. Although such a theory is clearly opposed to the assumptions of practically every worker in the field of thermal sensitivity, there has been little or no published criticism of it. It has been ignored—condemned apparently without a hearing.

The lack of adverse criticism and the engaging simplicity of the theory itself are likely, however, to lead to its acceptance by uncritical writers. Since the positive evidence for the theory is vigorously marshalled by Nafe,[1] we shall here concentrate primarily upon the negative.

Weakness of Nafe's general arguments. The indirect evidence which Nafe has marshalled to support the vascular theory is impressive in bulk, but does not stand up under critical analysis. In fact, only one of his many points seems to be really significant: that is, cold sensations from reflex stimulation. "It has long been known," he writes, "that certain screeching sounds produce feelings of cold and also in high fever one may have a chill." Such phenomena can be most aptly explained in terms of direct vascular activity. Examination of the other general arguments, however, reveals fallacies which will now be pointed out.

(1) Nafe attacks the classical Von Frey correlation (Krause end-bulbs for cold, Ruffini endings for warmth), citing the inability of investigators to identify such receptors histologically. He questions the assumption of *any* point-for-point correspondence between mapped temperature 'spots' and thermal receptors, citing the shifting of 'points' in successive mappings (but neglects the fact that Dallenbach has shown such shifting to be slight when the proper precautions are observed). He says that "Dallenbach has clearly shown that the results of all experiments . . . show these 'points' to be areas of the order of centimeters in size, rather than fractions of a millimeter," but he fails to give any specific reference for this highly questionable generalization. Our concern, however, is not with the validity of these statements, but with their bearing upon the question at issue. As arguments-by-exclusion, they do not constitute evidence for the vascular theory. Specific receptors do not need to be of the capsulated type; nor must they necessarily correspond point-for-point with mapped temperature 'spots' (the size and shape of which may be largely an artifact of the method of mapping employed). We may agree heartily with Nafe as to the inadequacy of these particular hypotheses, without accepting his vascular theory as the only alternative. Similarly, the fact that warmth and cold do not approximate the Weber-Fechner results, "in the manner characteristic of special sense-organs," offers no direct support for his theory.

(2) The histological findings which Nafe cites are meaningless. Strughold and Karbe (vital staining of the conjunctiva) found that "Krause end-bulbs themselves occur very near to masses of small blood vessels." Likewise, both Goldscheider and Von Frey, in their search for specific receptors, noted clusters of blood vessels "which, under the circumstances," Nafe states, "constitute direct evidence." This conclusion

[1] J. P. Nafe and K. S. Wagoner, The experiences of warmth, cold, and heat, *J. Psychol.*, 2, 1936, 421-431.

is unjustified. To constitute direct evidence, one-to-one correspondence between the blood vessel clusters and areas of thermal sensitivity must be shown. This has not been demonstrated in any of these cases.

(3) Nafe's tabulated "correspondence" between smooth muscle activity and thermal experience at various temperatures is thoroughly misleading. Take the experience of 'heat' as one specific example. "With increasing temperatures, other conditions being held constant, it [smooth muscle] relaxes up to about 45° C. At this point, isolated muscle elements begin to contract and as the temperature increases the contraction becomes more and more wide-spread." There are two objections to this explanation. (a) Heat is frequently reported with stimulator-temperatures considerably lower than 45° C. Lowenstein and Dallenbach found the median temperature for 100 observers to be 42.78° C.;[3] and for one observer the median was only 40.86° C.[3] (b) The measurements of Bazett, McGlone and Brocklehurst with buried thermocouples indicate that the temperature change at even a slight depth below the surface is only a small fraction of that represented by the difference between stimulator and skin temperatures.[4] Combining these two sets of facts, we find that 'heat' may be reported when the temperature at the level of the blood vessels cannot be higher than 40° C. and is probably lower. Similar objections apply to the low temperature end of the table.

(4) Another plausible argument turns out to be merely a matter of misinterpretation. "Bazett and McGlone," Nafe writes, "have shown that puncture of the arteries of the skin is likely to be accompanied by flashes of warm and cold." This is not true. Concerning the results of arterial puncture, these authors actually say that "the aching sensation is often associated with uncontrollable reflex reactions; the subject may complain of a sudden sensation of warmth; may break out into a sweat; may then feel cold, faint, or actually lose consciousness."[5] This is plainly a description of a widespread autonomic reaction (such as might occur with any severe pain). No localized 'flashes' of warmth and cold are mentioned.

Appraisal of Nafe's research. Nafe and his co-workers have published a number of research studies which can be conveniently considered here in four groups. One of these supplies an argument-by-exclusion for his theory; two others offer evidence of some direct connection between vascular activity and thermal experience; the fourth is of little significance for our problem.

(1) Two of the studies deal with the sensitivity of the cornea.[6] They show that the cornea has "no sensitivity to warmth or cold except at the extreme margins where the close proximity of the blood vessels gives rise to a presumption of a spread of effect." Since there are no blood vessels in the cornea, this provides an argument-

[3] E. Lowenstein and K. M. Dallenbach, The critical temperatures for heat and for burning heat, this JOURNAL, 42, 1930, 423-430.

[3] Lowenstein and Dallenbach, The limen of heat and some conditions affecting it, this JOURNAL, 49, 1937, 304.

[4] H. C. Bazett, B. McGlone and R. J. Brocklehurst, The temperatures in the tissues which accompany temperature sensations, *J. Physiol.*, 69, 1930, 88-112.

[5] Bazett and McGlone, Note on the pain sensations which accompany deep punctures, *Brain*, 51, 1928, 18.

[6] Nafe and Wagoner, The sensitivity of the cornea of the eye, *J. Psychol.*, 2, 1936, 443-439; The sensitivity of the cornea to heat and pain derived from high temperatures, this JOURNAL, 49, 1937, 631-635.

by-exclusion: *i.e.* thermal sensitivity is absent where blood vessels are absent. Unfortunately for the strength of this argument, the cornea is also devoid of about everything else, except some free nerve endings. Furthermore, if the apparent marginal sensitivity is actually due to spread of effect, it may be that the stimulation spreads to specific thermal receptors situated just beyond the margin. Nafe's conclusions from these experiments are therefore *non sequitur*.

(2) In a group of three experiments,[7] it was shown: (a) that stimulation of one hand alters by a fraction of one degree the threshold for warmth and cold in the contralateral hand; (b) that there is no measurable change in the skin temperature of the contralateral hand; and (c) that there is vaso-constriction or dilation in the contralateral hand. Since there is no significant temperature change, Nafe holds that the shift in threshold must be attributed directly to the vascular condition. This is certainly the simplest, but not necessarily the correct explanation. The studies of irradiation effects by Goldscheider[8] and by Gelhorn and Northrup[9] also gave results which are not explainable in terms of skin temperature changes, nor do they seem to be caused by vascular activity. The assumption of some 'central irradiation process' (however vague that designation must remain at the present time) seems to be required. This may also be the explanation of Nafe's results. Essentially the same central process may be the cause of *both* the vascular activity and the change in thermal threshold. The relation between these two would then be merely one of coexistence, not of causality.

(3) Another study,[10] which utilized the fact that stimulation of one hand by low temperatures produces vaso-constriction in the contralateral hand, showed that prolonged stasis of circulation in the contralateral hand causes this constriction to disappear. Thereafter, cold water introduced into the plethysmograph directly upon the contralateral hand leads to no sensation of cold (although warm sensations and vaso-dilation are still possible). "Consequently," Nafe concludes, "the failure of cold is related to the action of the muscles." We may accept Nafe's facts without accepting his interpretation of them. If there *are* any specific cold receptors, their action would certainly be impaired by such a prolonged cutting-off of their blood-supply.[11] Ultimately, they might fail to respond entirely. The critical question is one of the *exact* temporal relations involved. Nafe's conclusions are based upon a comparatively small number of experiments. The coincidence of the failure of vaso-constriction and the loss of cold sensitivity may not be as precise as he has been led to believe. More research on this point is needed.

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[7] K. S. Wagoner and E. C. Havemann, The effect of thermal stimulation of one hand upon the temperature limen in the contralateral hand; *J. Psychol.*, 2, 1936, 441-449; K. S. Wagoner, The effect of warmth and cold stimulation of one hand upon the skin temperature of the contralateral hand, *idem.*, 450-460; Nafe and Wagoner, The effect of thermal stimulation upon dilation and constriction of the blood vessels of the skin of a contralateral hand, *idem.*, 461-477.

[8] A. Goldscheider, Über Irradiation und Hyperasthasie in Bereich der Hautsensibilität, *Arch. f. d. ges. Physiol.*, 165, 1916, 1-36.

[9] E. Gelhorn and J. D. Northrup, The influence of spinal irradiation on cutaneous sensation. II. The effect of pain irradiation on temperature sensations, *Amer. J. Physiol.*, 104, 1933, 537-544.

[10] Nafe and Wagoner, The dependency of cold upon vascular action: Studies with nerve block, this JOURNAL, 49, 1937, 636-644.

[11] Experiments by the author (now in progress) show that even a brief stasis of circulation may reduce the length of adaptation-time very sharply.

(4) Less significant is the study which shows that water at 33° C. produces vascular dilation in the contralateral hand when the stimulated hand has been previously adapted to 15° C., and vascular constriction when the adapting temperature is 41° C.[12] It is to be expected that constricted (cold-adapted) blood vessels will dilate when exposed to a *relatively* higher temperature, and that dilated (warm-adapted) blood vessels will constrict when exposed to a relatively lower temperature. (Nafe has shown that such vascular activity is reflected in the contralateral hand.) This should occur, however, whether or not such vascular activity has anything at all to do with thermal sensitivity. So it is hard to see that this offers any special evidence in favor of the vascular theory.

Evidence against the vascular theory. Nafe disposes of the negative side of the case quite easily. "It adds to the value of the hypothesis," he writes, "that it fits all the experimentally demonstrated facts and does not conflict with any known fact or established principle."[13] On the contrary, there are a number of well-demonstrated facts which the theory does not fit at all, and at least one which seems to offer an insurmountable obstacle.

(1) Paradoxical warmth and paradoxical cold are inexplainable in terms of the vascular theory. Nafe has, at times, explained them both as being due to mechanical stimulation—but Alrutz secured paradoxical cold by focusing the sun's rays with a lens![14] Rubin obtained paradoxical warmth by lowering from skin neutral the temperature of a stimulator resting upon the skin.[15] Mechanical stimulation is out of question in these instances. To explain the phenomena purely in terms of the temperatures involved, it would be necessary to assume that some blood vessels contract when stimulated with a high temperature; some dilate when stimulated with a low temperature. Experimental demonstration of such contradictory behavior seems to be lacking.

(2) A number of chemical substances arouse cold or warmth when applied to the skin. In some cases, at least, these sensations appear to be the result of direct chemical action and not of induced changes in skin temperature. (Menthol, for example, gives a sensation of cold, but may irritate the skin and actually raise its temperature.) To maintain the vascular theory, it will be necessary to show experimentally that cold-inducing substances cause vaso-constriction consistently, and that warm-inducing substances always bring about vaso-dilation.

(3) That warm and cold spots can be stimulated mechanically and electrically has been generally recognized. In terms of the vascular theory, this must mean that, when subjected to the identical stimulation, some blood vessels constrict and others relax. Such an assumption will not be generally accepted in the absence of direct evidence.

(4) In mapping experiments, it has been the usual thing to find some areas of the skin which respond only with cold sensations and others only with warm sensa-

[12] Nafe and Wagoner, The effect of adaptation upon vascular reactions to thermal stimuli, this JOURNAL, 49, 1937, 645-649.

[13] Nafe and Wagoner, The insensitivity of the cornea to heat and pain derived from high temperatures, this JOURNAL, 49, 1937, 634.

[14] S. Alrutz, Studien auf dem Gebiete der Temperatursinne, *Skan. Arch. f. Physiol.*, 7, 1897, 333.

[15] E. Rubin, Beobachtungen über Temperaturempfindungen, *Zsch. f. Sinnesphysiol.*, 46, 1912, 392.

tions. For example, it is claimed that the uvula shows only cold sensitivity.[16] From the simplest interpretation of Nafe's theory, we should expect to find areas of warm sensitivity *coinciding* with areas of cold sensitivity—the blood vessels relaxing in response to moderately high temperatures and constricting with low temperature stimulation. But apparently it is not as simple as all this. Some blood vessels must constrict rapidly enough to arouse sensations of cold, but not relax rapidly enough to permit sensations of warmth. Other blood vessels must exhibit the opposite effects. This is not inconceivable, but highly improbable—in any case experimental proof is lacking.[17]

(5) Recent studies of the writer have indicated that the phenomena of adaptation are exceedingly complicated.[18] Positive and negative shifts of limen, long-continued after-effects, relations of the phenomena to the area, form and perimeter of the stimulator, together with wide individual differences, indicate that the basic physiological processes must be quite complex. To explain such effects entirely in terms of constriction and dilation of peripheral arterioles appears difficult indeed. Adaptation phenomena remain a definite barrier to the ready acceptance of the vascular theory.

(6) According to Kastorf, radiant warm stimuli separated by only a few tenths of a second can be sensed as discrete.[19] If this is true, a receptor mechanism which functions quite rapidly is implied. The sluggish action of smooth muscle is well-known. It remains to be shown that the smooth muscles of the arterioles can establish a rhythm of successive relaxations at the rate of several times a second (without intervening contractions rapid enough to be sensed as cold). Until this is demonstrated experimentally, Kastorf's results stand as strong evidence against the vascular theory.

(7) Thermal reaction-time seems to be another insurmountable barrier to the acceptance of the vascular theory. If the theory is to hold, reaction-time (say to a cold stimulator) must include time for penetration, vaso-constriction, afferent nerve conduction, central processes, efferent nerve conduction and reaction. Because the point is so critical for Nafe's theory, we may be justified in attempting to make some crude estimates of the magnitude of these components. (a) For temperature penetration, assuming the most superficial arterioles to be 200 μ below the surface and the rate of thermometric conductivity about 850 μ per sec.:[20] *i.e.* approximately

[16] F. Kiesow, Über die Empfindungsqualitäten der Uvula, *Arch. f. d. ges. Physiol.*, 56, 1926, 452-462.

[17] Having departed thus far from the original statement of Nafe's theory, we might go one step further and postulate that some groups of blood vessels are *capable* of giving rise only to warm sensations, however stimulated, and others only to cold sensations, which would meet all of the foregoing objections. This would be equivalent to converting them into pseudo-specific receptors—a virtual abandonment of the vascular theory as such.

[18] W. L. Jenkins, Adaptation in isolated cold spots, this JOURNAL, 49, 1937, 1-22; Studies in thermal sensitivity: 1. Adaptation with a series of small circular stimulators, *J. Exper. Psychol.*, 21, 1937, 670-677; 2. Adaptation with a series of small rectangular stimulators, *ibid.*, 22, 1938, 84-89; 3. Adaptation with a series of small annular stimulators, *idem.*, 164-177.

[19] F. Kastorf, Über die Verschmelzung der Warmempfindung bei rhythmischer erfolgenden Reizen, *Zsch. f. Biol.*, 71, 1920, 1-18.

[20] H. C. Bazett, B. McGlone, R. G. Williams and H. M. Lufkin, Sensation: 1. The depth, distribution and probable identification in the prepuce of sensory end-organs

230 m.sec. (b) For vascular constriction, considering the sluggishness of smooth muscles generally: at least 100 m. sec. (c) For afferent conduction, along small visceral afferent neurones at the rate of possibly 5 M. per sec.; 100 m. sec. (d) For central processes, efferent conduction and reaction of the finger on the key: possibly 100 m. sec. Adding these figures, we arrive at a total of something over 500 m. sec. as the necessary minimum. The average reaction-time to 10° C. (using a very small stimulator and no simultaneous tactual stimulation) is however, as low as 300 m. sec.[21] Earlier studies, using larger stimulators gave considerably lower figures: 200, 150 and occasionally lower. Even the largest of these figures is totally incompatible with the estimated 500 m. sec. needed for Nafe's theory. Unless the computations can be shown to be grossly faulty, the vascular theory appears here to have encountered an unanswerable objection. However frequent the co-existence of vascular activity and thermal experience, if there is not time enough, *the vascular activity cannot possibly be the cause of the thermal experience.*

Conclusion. Considering the crushing weight of the negative evidence and the inconclusiveness of the positive evidence, we conclude that Nafe's vascular theory is untenable as an actual description of the nature of thermal sensitivity. The assumption of specific warm and cold receptors is more valuable as a working hypothesis and it accords far better with the experimentally demonstrated facts.

Lehigh University WILLIAM LEROY JENKINS

ON COLOR CHANGES WITHOUT VARIATIONS OF WAVE-LENGTH

One of the most perplexing problems confronting any attempt to measure color lies in the fact that a change in hue can take place without a change in dominant wave-length.[1] The phenomenon is readily noticed in the case of papers colored by stipple or wash. In the Munsell system, for example, as a standard yellow sample is mixed with more and more black pigment, the mixture tends to give rise to a hue that is dark green. This effect usually obtains for normal *O*s under the conditions of ordinary daylight illumination. A similar phenomenon may be observed on a color wheel. By mixing 60 parts of saturated yellow paper with 300 parts of black by Maxwell's method, one perceives a hue which is olive green.[2] These and related phenomena have recently been introduced into purely systematic discussions.[3] These observations, however, can be shown to follow naturally from a present-day conception of color vision, and the purpose of this note is to provide the analytical procedure by which such effects can be accounted for theoretically in terms of two well-known neurophysiological principles.

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concerned in sensations of temperature and touch; thermometric conductivity, *Arch. Neurol. Psychiat.* 27, 1932, 498.

[21] W. L. Jenkins, Adaptation in isolated cold spots, this JOURNAL, 49, 1937, 13.

[1] Stimuli of fixed wave-length composition yield shifts in hue, in accordance with essentially the same rule as that said to govern the Bezold-Brücke effect; cf., L. T. Troland, *Principles of Psychophysiology*, 2, 1930, 173. See also, G. E. Müller, *Kleine Beiträge zur Psychophysik der Farbenempfindungen*, 1934, 120 ff.

[2] E. Brücke, Über einige Empfindungen im Gebiete der Sehnerven, *Sitzungsber. d. kais. Akad. d. Wiss., Math.-naturwiss. Classe*, 77, pt. 3, 1878, 39-71.

[3] E. G. Boring, Isochromatic contours, this JOURNAL, 49, 1937, 130-134 (and references there cited).

For the purpose of illustration, we may consider a specific instance. Two slotted 6-in. paper disks are mounted on a color wheel. One is "Hering yellow;" the other is black. When uniformly illuminated by light from a tungsten filament filtered to give a color temperature = 5200°K, the spectral composition of the reflected light for the yellow and black paper disks is that exhibited in Figs. 1

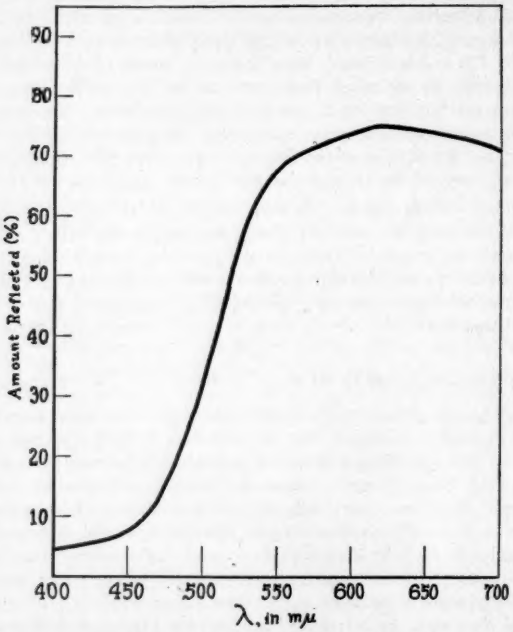

FIG. 1. SPECTROPHOTOMETRIC ANALYSIS OF LIGHT REFLECTED FROM HERING YELLOW PAPER

The ordinate values give the amount of light reflected per unit time expressed in percentages. The abscissa values are wave-lengths expressed in mμ. The maximal ordinate occurs at the wave-length = 620 mμ.

and 2 respectively. Each analysis was made with a photo-electric spectrophotometer, an instrument which measures the diffuse reflection factors of the paper relative to those of a magnesium oxide (non-selective) standard.[4] The amount of light reflected (per unit time) in percentage is in each case plotted against wave-length.

The figures show that, in the case of *each* paper, every wave-length in the visible spectrum is reflected into *O*'s eyes. For the Hering paper, the waves vary in ampli-

[4] A. C. Hardy, A photoelectric color analyzer, *J. Opt. Soc. Amer.*, 18, 1929, 96-117.

tude. The greatest amplitudes occur in the long-wave portion of the spectrum, and the maximal intensity is located at 620 mμ. The curve for the light reflected from the black paper is practically horizontal,[5] it exhibits no appreciable maximum, and its mean ordinate is relatively small. These two papers may now be rotated on a color wheel. A two pole synchronous motor operating on 60 cycles is used to revolve the disk at a speed of 60 r.p.s. When the papers are arranged so as to expose 60 parts yellow and 300 parts black, and when the illumination impinging upon the papers is approximately that of ordinary daylight, the perceived hue is not yellow. It is *green*. Twelve *O*s have observed the disks under these conditions. All reported the color to be a drab or olive green.[6]

In any study of color phenomena, the first step in attempting to comprehend the meaning of a reproducible result is to determine the intensities of all the wave-

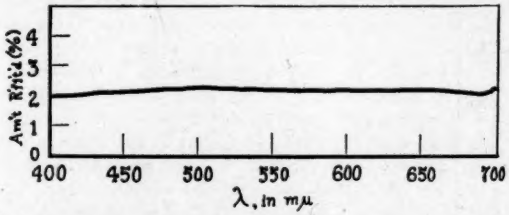

FIG. 2. SPECTROPHOTOMETRIC ANALYSIS OF LIGHT REFLECTED FROM A BLACK PAPER

The ordinate values give the reflectance, expressed in percentages. The abscissa values are lengths, expressed in mμ.

lengths actually entering the eye. The light directed toward the *O*'s eye from the black paper in the observations just described was exposed five times as long as that reflected from the Hering paper, during one revolution of the color wheel. Therefore, in order to measure the relative *amounts* of light for the wave-lengths directed toward the eye, we must weight the intensities accordingly. In the present instance, this weighting is properly effected if we multiply each ordinate in Fig. 2 by a factor of 5. The total exposure for any wave-length during one revolution is then directly proportional to the *sum* of its ordinate in Fig. 1 plus its weighted ordinate in Fig. 2. These relatively weighted ordinates and their sums are shown in Fig. 3. The broken line marked HY is again the curve for the Hering yellow;

[5] In general, Fig. 2 depicts the approximate form of the function relating stimulus-amount and wave-length when two complementary papers are mixed on the color wheel under ordinary daylight conditions to give gray (black-white continuum); see Troland, *op. cit.*, 66.

[6] When physically pure monochromatic light is used, however, there may be no such change in hue. At high intensities (ca. 500 millilamberts), for example, the hue associated with a monochromatically pure light ($\lambda = 587.4$ mμ is a highly saturated yellow. As the intensity is decreased, the yellow decreases in brilliance and saturation, finally becoming gray (at the non-chromatic interval). The various shifts in hue obtained for light from portions of a continuous, solar or tungsten, prismatic spectrum are possibly to be accounted for simply in terms of wave-length composition and the two well-known principles introduced in the present paper (*vide infra*).

the one marked WB is that for the weighted black. The solid curve is the sum of the two broken curves; it gives a measure, at any wave-length, which is directly proportional to the total amount of light at that wave-length which enters the eye during a single revolution of the color disk.[7] This total result is the light in response to which *O* ultimately reports the dark green hue.

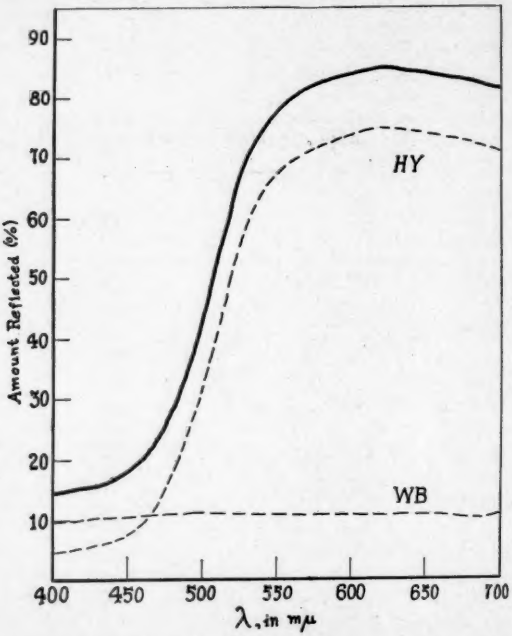

FIG. 3. SPECTROPHOTOMETRIC RESULTANT OF MIXTURE OF 60° OF YELLOW WITH 300° OF BLACK

The curve labelled HY is again that shown in Fig. 1; the horizontal curve (WB) shows the *weighted* reflectance for light from the black paper. The solid curve, at each wave-length, is the sum of HY plus WB, and it shows the amount of light directed toward the eye of the *O* during any single revolution of a color wheel which rotates at 3600 r.p.m. The dominant wave-length has not varied, but the amount of light entering the eye for the shortest wave-lengths has been increased relatively much more (ca. 200%) than the amount in the region of the dominant wave-length (less than 15%). For an explanation of the resultant shift in hue (from yellow to green), see text.

In spite of the fact that the *hue* has altered, Fig. 3 shows clearly that the dominant wave-length has *not*. At each wave-length, a constant amount of light has been

[7] An artificial pupil can of course be used to eliminate the effect of fluctuations in pupillary size. A better device is a highly corrected ocular, the eye-ring ('exit-pupil') of which is less than or equal to 2 mm. diam. See A. H. Holway, On the

added to that reflected from the Hering paper during one revolution, and the position of the maximal ordinate ($\lambda = 620$ mμ) has not changed. The figure, however, does reveal a marked *relative* change in the intensities for the different wave-lengths. The summed intensities for the short wave-lengths have increased relatively more than those for the longer wave-lengths. Through the addition of an approximately equal amount of light (= WB) to the HY curve at each wave-length, the amount of light for the shortest wave-lengths has been increased practically 200%, while the increase in the region of the dominant wave-length is actually less than 15%. Clearly, this fact must be taken into account in our search for a reasonable explanation of the observed change in hue.

The rôle of intensity, however, can be best understood in terms of neurophysiological activities, and we shall now briefly consider the relevant neurophysiological principles. According to Helmholtz, only three types of nerve-fibers are needed for the perception of all hues: (say) the R, G, and B types.[8] A yellow hue results when a sufficiently large portion of the total excitation in adjacent (central) optic nerve fibers is localized in, and equally divided between, the two sets of fibers held to be responsible for red and green. Let us suppose this to be the neurophysiological condition in our *Os* when stimulated by light reflected from the Hering paper *per se*. As seen above, by adding the light from the black paper, we increase the stimulus to these three types of fibers by equal, or unit, amounts. Now, for any visible wave-length, the increase in nerve-excitation and also in subjective brightness per unit increase in light intensity appears in general to follow a law of diminishing returns.[9] For our data, this means that a unit increase in the amount of light entering the eye for the short wave-lengths probably gives rise to a relatively greater increment in the excitation of the B-fibers than the same unit increase for the longer wave-lengths gives to the R- and G-fibers (*cf.* Fig 3).

The net neurophysiological effect occasioned by the addition of light reflected from the black paper to that reflected from the Hering paper can be epitomized as follows. The increase in the excitation of the R- and G-fibers due to the increase in stimulus amount in the region of the longer wave-lengths is small compared to the increase in the excitation of the B-fibers due to the same increase in stimulus amount at the short wave-lengths. This occasions a reduction in the saturation of the yellow hue.[10] In addition to this reduction in the saturation of the yellow, moreover, there

precision of photometric equations, *J. Opt. Soc. Amer.*, 27, 1937, 120-123. When the field-lens and eye-lens are properly adjusted, only parallel light can enter the eye; under these conditions the physical properties of a very large and sharply defined light image can be accurately regulated in the dioptric focal plane of the eye. Cf., also, W. J. Crozier and A. H. Holway, Theory and measurement of the visual response: I. A visual discriminometer, *J. Gen. Physiol.*, (in press).

[8] H. v. Helmholtz, *Physiological Optics*, II, Eng. trans., 2, 1924, 431 ff.; cf., also, Brücke, *op. cit.*, 50 ff.

[9] This is certainly true for the *retinal* response. At any wave-length, the first derivative of the function relating the retinal response and light intensity is a single-valued, monotonic, *decreasing* function of the intensity itself. This follows directly from a consideration of the data presented by Chaffee *et al.* Consider, for example, the figures presented in E. L. Chaffee and A. Hampson, Effects of varying the wave-length of the stimulating light upon the electrical response of the retina, *J. Opt. Soc. Amer.*, 9, 1924, 1-25. For a discussion concerning the relation between subjective brightness and the stimulus, see P. G. Nutting, The complete form of Fechner's law, *Bull. Bur. Stand.*, 3, 1907, 59-64.

[10] This type of analysis can obviously be employed to account for changes in

is also the further increase in the excitation of the G-fibers due to the relatively large increment (ca. 30%) in the amount of light at the region of 505 mμ (green). Under favorable circumstances, this in itself would be expected to give the color a greenish tint.[11] In conjunction with the fact of the necessarily desaturated yellow, it provides a sufficient explanation of the observed shift in hue (from yellow to green) in terms of two well-known psychophysiological principles.

Harvard University ALFRED H. HOLWAY

Henry Herbert Donaldson: 1857–1938

Henry Herbert Donaldson, professor of neurology and a member of the Wistar Institute of Philadelphia since 1906, died in his eighty-first year on January 23, 1938. He was born in Yonkers, N.Y., on May 12, 1857. Though the last half of his life was devoted to neurology and neuro-anatomy, psychology was his chief interest during the early part of his scientific career. That he never completely detached himself from his early interest is evidenced in his writings and also by his unbroken affiliation with the American Psychological Association, which he joined soon after its founding.

After attending the College and the Sheffield Scientific School at Yale and the College of Physicians and Surgeons at Columbia he went, in 1883, to Johns Hopkins University as an instructor in biology. G. Stanley Hall joined the Hopkins staff at the same time, and Donaldson, attracted to the 'new psychology,' was soon working in Hall's laboratory.

Donaldson's first study, made in collaboration with Hall, was concerned with the perception of movement.[1] He sought to determine how far and how rapidly an object had to be dragged over the skin to be perceived as moving. This investigation led him to inquire how temperature affected the movement-perception. He accordingly contrived thermal stimulators through which warm or cold water could be run, and attached them to the kinesimeter that he and Hall had devised for the experiment on movement. While the first study has long since been forgotten, the second, on the temperature senses, is numbered among the psychological classics. In this, he discovered that the skin is not uniformly sensitive to warmth or cold and that the temperature responses are specific and punctiform.[2] That he had been anticipated by Magnus Blix in Sweden and by Alfred Goldscheider in Germany

saturation which take place when the illumination from rotating colored disks is uniformly increased or decreased.

[11] The light reflected from other pigment mixtures (paints) can be subjected to the same type of analysis as the one outlined in the present discussion. The mixture of blue and yellow paints or color washes, for example, often give rise to a green color (hue). This case, however, is analogous to the *subtractive* instance in which two differently colored filters are placed in the same (heterogenous) light beam. The result is a measurable shift in the dominant wave-length. It is only very recently that the results of such mixtures have been studied quantitatively. For a quantitative demonstration that lights reflected from such mixtures obey the subtractive laws, cf., F. F. Rupert, A study of pigment primaries and mixtures, *J. Opt. Soc. Amer.*, 20, 1930, 661-684.

[1] H. H. Donaldson and G. S. Hall, Motor sensations on the skin, *Mind*, 10, 1885, 557-572.

[2] Donaldson, On the temperature-sense, *ibid.*, 399-416.

does not detract from the importance of his work. He made his discovery independently and, in attempting to identify the functional end-organs, he went further than either of his predecessors. His search for the end-organs led to negative results. He found numerous nerves beneath the excised cold and warm spots, but no specialized nerve-endings; and despite repeated attempts that have since been made by many men, with various refinements and improvements in technique, Donaldson's results still stand.[3]

After the doctorate at Johns Hopkins in 1885, Donaldson remained there as an associate in psychology until Hall left for the presidency of the newly founded Clark University. In 1889 he joined the brilliant group of men whom Hall had gathered round him at Clark as assistant professor of neurology. His life's work was then definitely decided.

Donaldson published six papers in this JOURNAL. The first, the leading article in the second number (February, 1888), was "On the relation of neurology to psychology," and all of the later papers were likewise concerned with neurological matters of psychological import.[4]

In 1892 Donaldson went to the University of Chicago as professor and head of the department of neurology and dean of the Ogden (Graduate) School of Science. He carried the dual tasks until 1898 when he resigned the deanship to devote himself entirely to his own department. In 1906 he left Chicago for the professorship of neurology in the Wistar Institute. Though retired in 1930, he continued there, as a member of the Institute, until his death.

Dr. Donaldson received many honors in his long scientific career. An honorary D.Sc. degree was conferred on him by Yale University in 1906. He was a member of many learned societies in this country and abroad, including the National Academy of Sciences, the American Philosophical Society, the American Neurological Association, the American Psychological Association, the Association of American Anatomists, of which he was president in 1916, and the Royal Institute of Lombardy, Milan, Italy.

Dr. Donaldson's death removes from American science a figure of international fame and a pioneer in experimental psychology.

Cornell University K. M. DALLENBACH

[3] Cf. K. M. Dallenbach, A bibliography of the attempts to identify the functional end-organs of cold and warmth, this JOURNAL, 41, 1929, 344.

[4] Donaldson, On the relation of neurology to psychology, this JOURNAL, 1, 1888, 209-221; Anatomical observations on the brain and several sense-organs of the blind deaf-mute, Laura Dewey Bridgman, *ibid.*, 3, 1890, 293-342; 4, 1891, 248-269; Notes on models of the brain, *ibid.*, 4, 1891, 130-131; The extent of the visual area of the cortex in man, as deduced from the study of Laura Bridgman's brain, *ibid.*, 4, 1892, 503-513; (with T. L. Bolton) The size of several cranial nerves in man as indicated by the areas of their cross-sections, *ibid.*, 4, 1891, 224-229.

BOOK REVIEWS

Rediscovering the Adolescent. By HEDLEY S. DIMOCK. New York, Association Press, 1937. Pp. xx, 287.

No more important contribution to the psychology of adolescence has appeared in many years. Here are new findings, some notable alterations to preceding findings, and certain supposed facts placed on a much more secure basis. The author had the privilege of studying repeatedly for a period of two years a group of 200 boys, and to gather other data from much larger groups. The group of 200 so closely studied were 12–14 yr. of age when the research began. Unfortunately the study was limited to the one sex and to no very wide sampling of boys from the various social classes. The subjects were in Y.M.C.A., Scout, 4-H clubs, and the like. The lower-class gang type reached by Thrasher was not so well represented here. Despite these limitations the study remains and will long remain an important contribution which no one who specializes in the psychology of adolescence can afford to neglect.

Among the more interesting of the methods used was the careful recording of the activities of each boy during the course of a day. When consolidated these revealed the typical day's activity for each age in the group studied. Comparisons of such presentations through the years reveals again that the proportion of time devoted to reading declines from 12 to 16 yr.; that the amount of time devoted to study increases; that the amount of participation in physical play declines; and that the amount of time devoted to watching others participate rises. Activity in boys clubs of the various kinds declines through those same years. Play activities were found to change with age and apparently these changes had little if any relation to pubescence.

The study of the social relations of the boy constitutes a large and important part of the investigation. Friends are found to approximate each other in chronological age, to come from about the same socio-economic status, and to have about the same intelligence quotient. An ingenious manipulation of the data on friendships produced a score for social acceptability. This correlated high with behavior adjustment and low with personal appearance. Parental relations were studied only for progress in emancipation, although these ages were obviously too young for the more serious phases of parental emancipation problems to arise. The degree of emancipation seems for the group studied to be but slightly correlated with age (0.14). Physical size, height and weight and physical strength, however, give correlations somewhat higher, (0.24, 0.24, 0.22). Those of the group found to be most emancipated from parental control were found also to be less critical of themselves, with less feeling of difference either of superiority or inferiority. Groups were classed into the "cohesive" and the "non-cohesive" form. The average age of the most cohesive groups proved to be 12 yr. The author believes that the assertions frequently made about team activity not appearing until a somewhat later age than this are false. He thinks that the failure to develop team play earlier is due to the attitudes and beliefs of those who attempt to lead boys into such team play.

There is one chapter on the moral and religious thinking of adolescence which, as is so often the case in studies of adolescence, is about the weakest of the lot.

Two chapters are devoted to the presentation of the findings about pubescence and its effects. These indicate the best study of the subject by far for many years.

The criteria of pubescence used were those of Crampton and here unfortunately the author had measurements on a much larger group, over 1400 boys. He found the average of pubescents to be 13.08 yr. Comparison of this with the earlier studies of Baldwin and Crampton raise the interesting question, is the average age of puberty declining? For this the author has no answer, and in fact the amount of decline so far is very slight, although it is suggestive. Careful comparisons were made of growth in height, weight and motor ability with the phases of pubescence. The most rapid physical growth was found during the period of shifting from pubescence to post-puberty. The most rapid development of strength follows the acceleration of growth in stature. The long accepted notion that youth is prone to be physically awkward during these years was studied by use of the Brace tests of motor ability. Many findings are reported among them being that there is a fairly constant growth in motor ability. This progress suffers some reduction after puberty has passed but before the advance in height and weight. Curiously enough boys who grow rapidly in height and weight gain as much in motor ability as boys whose growth is meager. The question must be raised, however, if the Brace tests measure what is commonly referred to as adolescent awkwardness. The author thinks they do but it seems equally possible that the awkwardness of popular observation is more an emotional disturbance brought about through the effect of changes of size upon social attitudes and social perceptions.

Throughout this study the author seems especially oriented by a desire to disprove the old and long abandoned notions of G. Stanley Hall about the rapid outburst of great changes in the body and personality with pubescence. He mentions, it is true, that most well-informed psychologists have abandoned such notions, nevertheless, he constantly lapses into a style of presentation which continues to reveal this motive. The whole book is characterized by an air of superiority scarcely becoming a scientific investigator. Frequently the author introduces a topic by telling the reader how startling or how surprising the material to follow will be found. Even the title of the volume reflects the same attitude. Surely the adolescent is not 'rediscovered' by this study, and in the face of the vast number of publications on adolescence in recent years it is a question if the adolescent needed to be rediscovered. Some of the literature is referred to and occasionally the results presented are compared with the results of others; but there is not nearly so much of this articulation with the work of others as the practiced reader would expect. The author states that the full presentation of his work with all of these relations will appear in a monograph but that is unfortunately not yet available. Perhaps also this inclination to lean on the other and fuller presentation of data explains why such items as the statistical significance of differences do not always appear. This inability to get at the full presentation of data makes any detailed criticism of this work at present impossible. The author hopes that this volume will serve the teacher of the subject and also "those persons who are working with" adolescents. Certainly all teachers must hereafter make much use of this material but the style is often so heavy and the pages so packed with figures that the mere "worker" with youth may find this prohibitively difficult reading. It is neither a complete monographic presentation of the research conducted nor is it a popular presentation for the use of the average man. Both are still needed and there is ample material here from which to make two very valuable publications of these kinds.

Indiana University EDMUND S. CONKLIN

Coöperation and Competition among Primitive Peoples. Edited by MARGARET MEAD. New York, McGraw-Hill Book Co., 1937. Pp. xii, 531.

This book is an assembly of material on primitive societies written to lay the groundwork for research in our own society. Commissioned by the Social Science Research Council, Mead engaged in this ambitious work with six collaborators, conducting the inquiry as a seminar, from which emerged thirteen studies of primitive societies (two by Mead and the remaining eleven by her colleagues), and an introduction and an interpretive statement by Mead. For every society is presented the natural environment, the state of technology, the methods of production, the social structure, and the educational practices. From the first the syncretic principle is adopted in order to give the terms *coöperation* and *competition* a significant context. The behavior of the individual of each group is studied as a relational emergent from the social system to which he belongs. The abundantly verified fact is recognized that the act of an individual, taken in isolation from its determining social context and without the relationship of the performer to the social scheme of things, is in principle irrelevant to the subject of study. For what may be competition in one social context will be coöperation in another, in accordance with variations in the social configuration. The groups scrutinized ranged in the final estimate from the profoundly coöperative Bathonga to the equally competitive Kwakiutl. As the work developed it became necessary to allow for a third category, to which the Eskimo is considered to belong, the *individualistic,* wherein a person strives toward his goal without reference to others.

Not only is the theoretical basis of the work avowedly configurational, but the conclusions are explicitly environmentalistic. Perhaps the most fundamental conclusion to be drawn from the study is that competitive, coöperative, or individualistic behavior of the individual is conditioned by broad social emphasis. This conforms with the already established facts of anthropology and psychology that the characteristic goals of effort are culturally determined and formulated, and do not consist merely of the culturally undefined satisfaction of tissue needs like nutrition. Another important and stimulating conclusion that issues from the work as a whole is the principle that the mechanism of the distribution of goods is primary in determining the emphasis of a society upon coöperation, competition, or individualism. While not exactly novel, it is well to record once again the economic determination of cultural patterns of behavior.

This work provides a helpful exploration of possibilities as a basis for proceeding with a similar investigation of civilized society. If it had done no more by its broad sampling of primitive societies than dispel the impression that the same act is unanimously significant in all groups, it would have served a useful purpose. But it has emphasized a promising method of the case studies of individuals for their significance to the interpretation of group life as a whole. In this regard, Mead samples widely within a culture for cases of both conformity and deviation from normal of individuals and situations as well. By this means she succeeds in placing a functioning organism with all its dynamic interrelationships under scrutiny. It is at once seen how useful this procedure is to any study of our society, for it shows that the problem of coöperation and competition must quickly widen to a study of personality as a whole as a function of culture.

With all its merits, the book is disfigured by certain defects which are attributable to the editor. It might be held in general that in the editor's interpretation of the

data there is a too heavy leaning on a rational basis in the objective situation for the practice of coöperation, competition, or individualism. It is true that conditions rationally influence the choice; but it is also true that irrational tradition operates to some degree. Mead makes insufficient allowance for the irrational survival of outmoded practices. If the underestimation of social lag among primitives where the tempo of social change is slow may be serious, it may be fatal to sound interpretation of civilized behavior where the tempo is rapid. It is recognized that even the social sciences are sufficiently developed to make rational progress in civilization largely a matter of education, a matter of reducing the shocking distance between what the initiate experts know and the vulgar believe. For this reason, especially when civilized societies are reached, it will be necessary to make sure that cultural lag be given ample prominence.

In the matter of style and presentation one wishes that Mead had taken a hint from her colleagues, who write with directness, lucidity, and an engaging simplicity which springs from an exclusive concern with the material and an avoidance of literary elegance. Mead's writing, on the other hand, is definitely mannered in several respects. In the first place, although she is punctillious in disavowing unverifiable certainties, she allows a certain magisterial insistence to creep into her statements. More specifically, her presentation is the despair of the student: it is unduly tense, electrical, overcharged—in a word, fatiguing. Moreover, one feels mauled by the surge of ideas that she fails to hold in check, and that over-acute distinctions and too much erudition stand between the meaning and the reader, so that fortuitous excursions interfere with fundamental expressions. This unnecessary arduousness grows out of her apparent desire to avoid perfunctoriness; but the avoidance of this does not necessarily entail the sacrifice of tranquility.

Sarasota, Florida ELLIS FREEMAN

Menschen der Südsee; Charaktere und Schicksale. By HILDE THURNWALD. Preface by Richard C. Thurnwald. Stuttgart, Ferdinand Enke Verlag, 1937. Pp. vi, 201.

In *Menschen der Südsee,* Hilde Thurnwald describes the personalities of a colorful group of individuals and thus depicts the life and culture of the primitives in Buin—a section of Bouganiville Island of the Solomon Archipelago.

Her method of approach is novel in ethnology. Setting individuals at the center of her work, she describes their beliefs, feelings, and actions in normal and critical situations. Numerous photographs of life situations are given and the reader can readily check her descriptions of their physical aspects. Sixteen well-selected characters are described in cross-sections of daily life.

These character-sketches are preceded by an introduction in which the racial history of these people is traced and the formation of their three-class system—*múmira* (chieftain), *minei* (half-breed), *kitere* (bondsman)—is described. This not only sheds light on their existence and environment, but also serves to refute the claim of determinism.

Despite the external and formal influences of occidental civilization (exerted mainly by the Australian government and missionaries), the entire cycle of Buin existence is rooted in tradition and a belief in magic. Love (*kuči,* pp. 124, 139, 141), good fortune, and evil are guided and controlled by their belief in supernatural

agencies. Human-like demons, with moods, passions and intrigues reside in trees (pp. 60, 62) and lay their curses on men (pp. 65, 183, 191).

The intelligence and behavior of these natives vary widely. Women are considered, with some exceptions, to be self-assertive and inferior in every way. Attention, *i.e.* the ability to concentrate, although showing marked individual differences, is usually of short duration and is to a great extent conditioned by mood. Voluntary integrative action is, however, of longer duration (p. 136).

The Buin man is generally an incalculable individualism. The will to exist, irrespective of all conceptions of value, makes him act primarily by natural instinct, with no rational consideration for the situation or the consequences (pp. 51, 97). Unusual sensitiveness, inflamming ire, revenge, and envy, prompt him to impulsive reactions, which, according to temperament, are more or less vehement. The law of recompense demands material satisfaction for guilt. Actions, when free, are directed by sympathy and antipathy—the basic elements for the principle of evaluation stressed by modern characterology. In matters of tradition personal wishes are quickly changed into general attitudes (p. 35). Little sentiment, at times degraded to mercilessness, marks the egoistic Buin man. Theft is unknown; only a cleptomaniac needs to be feared (p. 88).

The characters described exhibit individual peculiarities, in spite of exposure to similar environmental influences, and they could serve as different types in modern characterology.

The author is a capable narrator, a shrewd observer, and a careful, objective interpreter of human expressions. She has exposed a wealth of material that deserves the attention of all interested in comparative psychology and characterology. Her descriptions refute the materialistically belief that people, especially primitive, show similar characteristics under the same environmental influence. *Menschen der Südsee* is an exponent of the movement in racial anthropology to establish a reliable science of "man himself" as the carrier and measure of his environment anywhere and at any time.

New York, N.Y. LUDWIG SCHOPP

Social Behavior and Child Personality. By LOIS BARCLAY MURPHY. New York, Columbia University Press, 1937. Pp. viii, 345.

The unassuming sub-title, *An Exploratory Study of Some Roots of Sympathy,* gives a precise impression of the contents of this work. It is mainly a study of children's responses to distress in other children, and extends into those areas of cooperation which also compose concrete sympathy. The data were gathered by trained observers at the Child Development Institute. The subjects were young children, definitely superior in IQ, and largely of parents connected with Columbia University as students or teachers. It is a pleasure to find the author acutely aware of the limitations of her opportunities and of the methods employed. This critical viewpoint which dominates the work reënforces one's confidence in the soundness of her tactfully presented and cautiously phrased conclusions.

One of the great merits of this investigation lies in the heavy weighting of culture in the determination of personality. In this general respect agreement is complete with Mead, Benedict, and the others of the Columbia school of anthropology. More specifically it emphasizes the fundamental aggression-sympathy dualism in our cul-

ture, which predetermines the unlikelihood of developing personality on an exclusive pattern of sympathy. Murphy does not find it impossible to endure the implications for the development of personality of a society which harbors side by side the grim tradition of aggressive exploitation and organized charitable amelioration of the suffering which results. She is aware that the child must necessarily become the product of these incongruous values, which on the one hand are highly personal and on the other to a smaller degree social. But to her it is also evident that within this dualistic framework special personal and environmental conditions will develop in some a polarity of emphasis on one of the two extremes. Thus she accounts for individual differences within the broader lines of conformity.

She finds that far from a mere summation of traits, no account is workable without a broad context of individual biological idiosyncrasies, circumstances of the particular situation under scrutiny, and the unevaluated influence of the attitude of the observer. To this she adds for special emphasis the long-term congruence of personality drift, detected under variable conditions of response. Although this drift will have a determining tendency, neither aggression nor sympathy may be defined as separable, constant entities. The individual's patterned status as a whole in a wide range of situations can alone reveal dominant trends and dynamic variations. Thus an aggressive child expresses sympathy by active, aggressive interference, while a submissive child may do so by a warning or protest. Sympathy may take the form of defense of the victim, or it may become an attack on the malefactor. The author is sound in cautiously regarding this as confirmation of the intimate interdependence and congruence of personality factors.

As might be expected, there rises into prominence here the great need of a suitable technique for eliminating the effects on data of the inadvertant assumptions and personal attitudinal factors of teachers and observers. A further elaboration of the already formidable statistical machinery does not promise to do so. There is also no reason to suppose that the observation of behavior in spontaneous situations yields more of the personality than do the 'framed' situations. The latter offer an opportunity for better controlled work and call for more attention, as Murphy recognizes. This investigation, especially serviceable in deepening and extending hypotheses, has defined a fruitful approach to the social aspects of personality.

Sarasota, Florida ELLIS FREEMAN

Infant Speech: A Study of the Beginning of Language. By M. M. LEWIS. New York, Harcourt, Brace & Co.; London, Kegal Paul, Trench, Trubner & Co., 1936. Pp. xii, 335.

The author, senior lecturer in education in University College, Nottingham, England, had as his object in writing this book the question: "How are those characteristics of speech, which we usually see flowering during the course of a child's second year, related to his earlier experience and behavior?" He based his answer upon the detailed observations of one child, a boy, "whose physical development has been normal." He recorded the boy's sounds and made full notes of the conditions of their utterance and of the boy's responses to the speech of others.

The author begins with a general discussion of the outstanding characteristics of language. He stresses the point of view of regarding language in terms of the speaker, the listener and the situation; and he develops Bühler's views of the three-fold nature

of speech, according to which speech may be regarded as (1) expressive or emotive, (2) representational or referential, and (3) evocative. He leans toward the view that the conceptual use of words arises out of communal needs in dealing with environment.

A large part of the book is devoted to the phonetic aspects of the development of language in early life. The sounds uttered spontaneously and in imitation by children during the first year of life are discussed, and the relation of these sounds to later phonetic standardization and to their inferred affective significance is treated in detail. A chapter is devoted to each phase of the problem which the author labels babbling and imitation. His discussion of babbling as a form of art should be especially provocative for many readers.

The acquisition of conventional speech is treated as a response to adult speech. Conventional speech, according to the author, is preceded by a period during which the child utters certain words, not with reference to particular objects, but consistently according to the situations in which they are used. In considering the details of the transition from this general type of speech to the more standardized and conventional forms, the author is handicapped, in the opinion of the reviewer, by a lack of adequate data which would enable him to answer the many specific questions which arise, *e.g.* Are the front-consonant forms connected with the child's sucking-movements? Is there some significance in the fact that the mother is usually named with an m-form, the father with a p, b, t, or d-form? The author lacks the data to answer such questions and his discussion of the views of Wundt, Stern, Jespersen and others hardly serves the purposes of adequate interpretation.

The chapter on "The Expansion of Meaning" contains some of the most significant material in the book. Here the author points out that as words become standardized in their meanings for the child, they become relatively generalized in meaning. We might say that the referential boundary of a word becomes increasingly stabilized for a given individual, but that this boundary may not be the same for one individual as for another, and that within the boundary very wide shifts in meaning are possible. In all probability, it was not the intention of the author to develop this phase of the problem of speech development and his relatively sketchy treatment of it should be judged in the light of this fact. Certainly, it would appear to be one of the most fundamentally significant phases of his subject.

The book represents an honest and serious effort to make a contribution toward a science of language, specifically spoken language. It would have been more significant, however, if the subject of meaning had been more fully treated. There is an index and a bibliography of the more important references. The data which the author obtained with regard to the speech of one child are presented in an appendix along with certain other compilations bearing upon the problem of infant speech.

University of Iowa WENDELL JOHNSON

Child Psychology. By FOWLER D. BROOKS, with the collaboration of Laurence F. Shaffer. Boston, Houghton Mifflin Co., 1937. Pp. viii, 600.

As noted in the preface, this book, covering the first twelve years of life, was "developed in connection with courses and addresses on child psychology." It may, therefore, properly be reviewed as a textbook in this field.

In addition to most of the topics we have come to expect in such books the author

includes prenatal development of structure and of function, principles of learning (contributed by C. R. Garvey), growth in bodily size, the development of physical capacities, children's character and children's religion, and guidance and control of child behavior. The inclusion of a chapter on the development of mental functions including attention and memory as special topics, and the omission of treatment of the origin and growth of meanings indicates the formal rather than functional organization, characteristic of the book as a whole.

The strength of the book appears to the reviewer to lie in the following: an easily readable, clear style; thorough grounding in the literature; annotated, selected references and additional references for each chapter; a detailed table of contents, a brief glossary and a detailed index.

As a textbook in child psychology the book has some marked limitations. Its encyclopedic nature makes it inclusive at considerable cost of unity and criticality. What justification can there be in a textbook on child psychology for eight pages on the mechanism of heredity, ten pages on prenatal development of structure and a whole chapter on growth in bodily size? It may also be questioned why a necessarily rather meager chapter on learning needs to be included. Has not the time come when psychology texts in the various specialized fields can be selective rather than attempt to be all-inclusive?

What profit to the reader is it to have "unreliable theories of child nature" treated? (6-10). Likewise, why present data which the author himself characterizes as unreliable? (301, 519). Failure to give clear legends makes some of the figures confusing (259-260). Considering that as a whole the book is obviously designed for readers of fairly high order of ability, certain naïve statements are annoying. Typical are the following: "In situations in which pain is reasonably sure to ensue, it would seem best not to deceive the child" (305). "The most important factors affecting the child's social development are environmental" (384). "The character of the parents and the kind of training they provide are powerful forces shaping the child's social development, especially those features which usually are characterized as morality" (387).

The book should be very useful as a direct source of much significant material on the topics treated and particularly as a ready reference to much of the literature in an extensive field.

Cornell University PAUL J. KRUSE

The Biology of Human Conflict. By TRIGANT BURROW. New York, The Macmillan Company, 1937. Pp. xi, 435.

The author of this volume sums up the researches upon which he and his coworkers at the Lifwynn Foundation have been engaged since the publication of his earlier work, *The Social Basis of Consciousness.* Herein are described the assumptions of phylobiology, the "science of behavior that rests upon principles which pertain to man's reactions as a phylum as they mediate his bionomic rapport with his social and material environment," and the method of phylo- or group-analysis. The conclusions drawn are supposed to have been reached by experiment, although a description of the experimental procedure and other materia pertinent to scientific investigation is lacking.

Dr. Burrow regards neurotic behavior as characteristic of the community as well

as the clinically deviate individual. The neuroses are brought about by disagreement or disparity of tensions between two physiological patterns of reaction within the organism: one pattern consisting of tensions belonging to the organism in its primary total behavior, the other embodying concomitants of its outer or secondary symbolic adjustments. The only therapy adequate is one which employs physiological measures.

From a strictly psychological point of view, the outstanding contribution of this work is the author's emphasis upon the body as the performing organism. He insists that conflict is physiological not mental. Neuromuscular modifications support and govern psychological functioning. Modern psychotherapy, seeking to remedy disorder, must abandon the view that "what are called mental measures of repair are applicable to what are called mental diseases." The physician must regard his patient's symptoms as indicators of underlying physiological disturbances. In all instances the treatment for disorder must be directed toward establishing a physiological balance within the organism. Since the same imbalance exists within the structure of society and among nations a similar procedure must be employed to cure a world plagued by war, greed, and intolerance.

The reader will be confused by a vocabulary that draws heavily upon standard terms interpreted to suit new occasions and a rather heavy literary style. He will also regret the absence of direct experimental exposition.

Cornell University ROBERT M. LINDNER

The Questioning Mind. By RUPERT CLENDON LODGE. New York, E. P. Dutton & Co., Inc., 1937. Pp. 311.

The author reflects upon various aspects of life from the viewpoints of realism, idealism and pragmatism. Taking the attitudes in the order here named, the interpretations follow: *Knowledge* derives validity from synthesis of perceptual elements; or, from transcendental ultimates; or from practical effectiveness. *The good life* is scientifically standardized hedonism; dialectical exploration and pursuit of ideals; or behavioristic acquirement of specific satisfactions. *Mind* passively apprehends reality; actively selects, integrates and transcends experience; or it is the social response of the organism. *The self* is a mind-body complex, free to realize its own destiny within the limits of heredity and environment, and immortal in so far as it leaves a residue of influence; or it is a fragment of the ideal self, free to exalt and transcend experience with spirituality, and to become an immortal part of the Absolute; or it is a socially interactive organism, free to exert itself toward concrete achievements, but with no integration or survival. *Education* is factual dictation and retention, tested by objective experiment and examination; or it is the fostering of the inner urge toward knowledge and development, tested by expression and organization of assimilated subject-matter; or it is an increasingly effective adaptation to contemporary life.

The book is erudite, yet naïve, filled with superfluous references and figures of speech. The interpretation of realism is limited and materialistic; idealism is expounded with exalted emphasis; to pragmatism is assigned the preparation of palatable hash. Beyond question is the author's fineness of motivation, which aims to clarify the thinking of those who feel naturally drawn to one, or confused by

all the philosophical approaches. It will give to the psychologist who critically appraises it, a broader orientation toward his data.

Ann Arbor, Michigan — BERENICE BARNES SHEPARD

Psychology of Feeling and Emotion. By CHRISTIAN A. RUCKMICK. New York and London, McGraw-Hill Book Co., 1936. Pp. xiii, 529.

Books on general topics separate into two major categories, the encyclopedic and the progressive. Dr. Ruckmick's work belongs to the former class. He has carefully arranged in a logical system the results of the theoretical and experimental explorations of the no man's land of feeling and emotion. In spite of his personal interests and enthusiasms, he has succeeded in matching the lengths of his chapters to the relative importance of their content. He devotes 231 pages to the description of feeling and emotion and the various theories concerning them, 181 pages to the experimental summaries, and 103 pages to conclusions and applications. The style is easy, graceful, clear, and moves with the slow and dignified rhythm demanded by so serious a subject. Apt quotations sprinkled skillfully through the text add seasoning.

The author believes that the affective consciousness or the simple feeling is primary, that it becomes increasingly differentiated and that it depends mainly upon the autonomic system as a nervous vehicle. A unitary composite of feelings separated temporally from other mental states constitutes the emotion. The emotion itself is a disruptor of mental and bodily life, is generally experienced at a high level of attention, has its own affective tone, and includes bodily responses both gross and incipient. Because of the association between emotion and bodily resonance, the methods of expression may be used in the study of emotion. Since emotion is also a conscious phenomenon, the method of impression may be used also. The two sets of results will supplement each other. The book closes with chapters on feeling and emotion and psychoanalysis, feelings and emotions in the child, in the animal mind, in the educational program, and on culture and the affective life.

It comes close to being non-sectarian except for its advocacy of dualism. On the whole, it is a backward looking book, relating what has been done, describing the controversies that have developed. It contains a rich fund of information that should prove useful both to teacher and to student. The author had no burning conviction that led to the exposition of a unique point of view. He has brought the reader up to date, but has failed to lead him ahead.

University of Michigan — HENRY F. ADAMS

Our Children in a Changing World. By ERWIN WEXBERG, with Henry E. Fritsch. New York, Macmillan Co., 1937. Pp. xii, 232.

This is a kind of book that can be either very useful or very harmful to readers who must "take it on the authority of the book;" useful if the author happens to be sound, harmful if it happens he is not sound, according to the best knowledge of the day. That is, it is a book in which the author presents little or no evidence from generally accepted authority or valid research in support of his position.

In the opinion of this reviewer the book will be very helpful to those for whom it is intended, parents and teachers, furnishing them "a concise review of the most common problems of childhood development, and of their solution by modern edu-

cational psychology." Far more useful than some of the books written by psychologists ostensibly for parents, teachers, and teachers-in-training, but actually to impress their colleagues. It is a relief occasionally to find a book that does not on every page flaunt its claim to being scientific, but rather shows insight into the meaning of the facts and principles of educational psychology in relation to the problems of child guidance, and courage enough on the part of the author to offer the results of his own critical analysis of the mass of experimental and observational data bearing on these problems. This book could be written only by one with thorough understanding of the psychological principles basic to effective child guidance and after much experience with children themselves.

Its three parts deal with the *origins* of childhood difficulties, the *problems* themselves, and *corrective measures*. It is built upon the thesis that "there are no bad children," but rather merely that some "fail to understand the advantages of social life," and holds that "our task . . . should be not to make the child 'better,' but to make him wiser."

As may be expected in a book of this type there are some statements which may doubtfully be defended in the bare form in which they are made. Such is the statement on p. 207: "With children, punishment should not be used at all." Such statements, however, are relatively few in number and, when taken in relation to the argument of the book as a whole, seem to the reviewer to detract very little from the volume's usefulness.

Cornell University PAUL J. KRUSE

A Pediatrician in Search of Mental Hygiene. By BRONSON CROTHERS. New York, Commonwealth Fund, 1937. Pp. xix, 271.

This book is a collection of essays on various aspects of child guidance, mental hygiene, psychiatry and pediatrics. Dr. Crothers states that "as a practitioner and as a teacher of medical students I have recognized with increasing clearness that pediatricians are, as a rule, quite unaware of many of the stimulating and highly significant contributions of the psychiatrists, the psychologists, the teachers, and the social workers in regard to children." On the basis of this conviction, Dr. Crothers attempts to point out how the pediatrician may profit from coöperation with workers in allied fields. As an example of such a program, he outlines in one of his chapters the methods in use at his own clinic at the Children's Hospital in Boston. The book is of specific interest to pediatricians, especially since it is written by an outstanding authority in the field. Psychiatrists will also find it of value inasmuch as Dr. Crothers deals quite extensively with the points of contact and relationships between psychiatry and pediatrics. A chapter of 20 pages is devoted to the rôle of the psychologist in a children's hospital.

As a practicing pediatrician, Dr. Crothers has found psychology and the work of psychologists of value, but he does not hesitate to point out wherein they fail. The author's comments on psychology are highly provocative and should prove stimulating to consulting psychologists and to those who contemplate entering the field. One great need was clearly brought to light from the reading of this book—the necessity for a *handbook of clinical psychology* for medical students and practicing physicians. Such a contribution would go far toward the substantial integration

of psychology into pediatrics, a need which has been clearly emphasized by Dr. Crothers.

The Training School, Vineland, N.J. ANTHONY J. MITRANO

The Human Mind. By KARL A. MENNINGER. Second edition, corrected, enlarged, and rewritten. New York, Alfred A. Knopf, 1937. Pp. xiii, 504.

Dr. Menninger's book presents orthodox Freudian psychology with but minor modifications, and presents its popularly, clearly and with no distortion in the process. It can be whole-heartedly recommended to those who wish a clear treatment of the nature of mental disease, the principles of analytic psychiatry and an accompanying mass of vivid case material. It should be pointed out, however, that although the book is addressed to the 'educated layman'—possibly even the 'man in the street'—as well as the student with some preparation, the former will receive the impression that the author's views are fully representative of modern psychiatry. He will be unable to put his finger on the points which are in controversy; in controversy even among those who are in agreement with the author upon such general principles as unconscious motivation.

Dr. Menninger's style is lucid and vigorous and he has a really brilliant gift for accurate popularization. For the general reader the book provides valuable information, a rich store of psychiatric wisdom, and some sections of the greatest practical significance; for example, the author's treatment of educational procedures in the chapter on "Applications." One is tempted, however, to criticize the argument by example, which, aside from logical difficulties produces a tendency to parade spectacular case material that almost overloads the positive features of the book. There is, moreover, a certain dogmatism in setting down principles, evident particularly in the chapter on "Motives." Of a piece with this fault is the cavalier treatment of non-psychiatric psychology. For instance: "Psychologists and philosophers have wasted much time and paper trying to decide just what constitutes intelligence whereas almost any school-child can tell you in a minute that it is the ability to learn." So accomplished a school-child could, no doubt, correct some of Dr. Menninger's faulty psychology, point out that "psychiatric counsel" can properly be classified with suggestive techniques and perform a number of similar useful services. The author has apparently been greatly impressed recently by the Gestalt approach, particularly as represented by Lewin and J. F. Brown, but has not actually modified any of his theoretical structure in terms of field-theory.

The reviewer would carp, finally, at the title, which seems to cover more territory than does the actual content of the book. For the lay reader none of the faults mentioned can be considered serious, and a widespread circulation of *The Human Mind* would serve a highly useful function. As a source of readings and case material the work can be very useful to the teacher and student.

Sarah Lawrence College LAWRENCE JOSEPH STONE

Life in a Haitian Valley. By MELVILLE J. HERSKOVITS. New York, Alfred A. Knopf, 1937. Pp. xvi, 350, xix.

This book is an interesting example of the contrast between the lurid tales of West Indian voodooism and careful anthropological research and was instigated

by an adverse review of a book on Haitian culture by the author of the present work.

After describing their African heritage and the peculiar mixed French culture into which the negro slaves were imported, an intimate picture is given of the daily round of life in a small valley in which the author lived in 1934. One of the interesting features of their working customs is the *combite,* in which a considerable group work together voluntarily to the rhythm of drums, thus accomplishing unusual feats, while also enjoying sociability with songs.

The chief contribution of the author is in giving a clear account of the vodun (voodoo) worship and dances, which are a curious combination of African belief in spirits and magic and of Roman Catholic ceremonials. The vodun worship is a private ceremony, but the vodun dances are public and at once religious and recreational. The "possession" of individuals by the spirits at these rites is shown to be socially controlled, but the author points out that its psychology needs further study. There is an obvious similarity to the religious revivals of the Protestant negroes in the southern states, and a comparison of the psychological phenomena should be instructive. The African and Roman Catholic influences in the present "cultural mosaic" are clearly analyzed.

Although the chief emphasis is on cultural dynamics, the influence of culture on personality is stressed and a very interesting hypothesis to account for the observed instability and nervous tension of the natives, shown by their craving for excitement in games of chance and in the vodun dances, is advanced. It is held that the two ancestral elements of their culture have never been completely merged and hence produce an inner conflict of what the author calls "socialized ambivalence." This is suggested as a lead for "a more realistic understanding of the individuals in other cultures who have likewise fallen heir to conflicting traditions."

In conclusion, the author discusses the significance of his findings as a means to the understanding of negro culture in the United States.

Cornell University DWIGHT SANDERSON

Human Psychology. By JUDSON REA BUTLER and THEODORE FRANCIS KARWOSKI. New York, Pitman, 1936. Pp. xvi, 447.

This book was intended for use as an introductory text. I can find in it no principle of organization of the material. It is written loosely throughout. Some portions are cast in ornate English, which is indeed rhythmic, though not always grammatical. Its misstatements of fact are too numerous to be listed here. Some of the accounts presented as historical are so inaccurate as to raise doubts of the authors' acquaintance with the original material. Many statements of hypothesis or of surmise have the form of statements of observational fact. I quote one instance, which I selected as a Hardshell preacher selects his text:

"Memory Cannot Be Improved. The bare retentive power of the mind, since it is the functional correlate of structural changes in the brain, is determined by an inherited plasticity of nerve tissue. No amount of effort or training or culture can bring about any improvement in this retentiveness. Once laid down in the germ plasm, it is fixed for the lifetime of that individual. And while disease and injury and senile deterioration may impair it, nothing can change it for the better. It seems to fluctuate with interest, to be better in health than in sickness. . . . It is important that one should make the most of natural aptitude by efficient methods of learning and organization." (337 f.)

If a sophomore should ask me how the authors could have verified the first four

sentences in this passage, I should have to answer that I could not even guess. If he should ask me how something that is fixed for the lifetime of an individual can during his lifetime fluctuate or be impaired, I should have to tell him, "No how." He could find many other assertions in the book which would invite similar questions, and thus call forth similar answers. I should dislike the task of defending it.

National Research Council, Washington, D.C. H. M. JOHNSON

L'intelligence avant le langage. By PIERRE JANET. Paris, Ernest Flammarion, 1936. Pp. 292.

Janet, always original and spirited, offers in this new volume, a kind of social psychology of language—from the dynamical viewpoint that he originated some years ago. He attempts to discover the aboriginal activities from which man's language has developed. Using impressive and amusing examples, he describes the following descending categories. (1) Quantity: collecting (panier de pommes), distributing (part de gateau), dividing, and individualization. (2) Social relations: symbol and sign as intellectual portraits. Commanding and obeying as the most elementary social activities. (3) The course of time: memory and image. Reading and writing as originating from imagination. The representation of past, present, and future. (4) Elementary intelligence: numbers, words, abstraction and generalization. Invention as a sign of elementary intelligence. The last chapters are devoted to a highly interesting study of the mutual influence of social activities and language—showing how language itself evolves with the development of the civilizative process, and how it, on the other hand, contributes to the wider development of culture.

New York, N.Y. ERNST HARMS

Interracial Marriage in Hawaii. By ROMANZO ADAMS. New York, Macmillan Co., 1937. Pp. xvii, 353.

Dr. Adams has produced a very satisfactory and interesting study of interracial marriage in Hawaii based on a thorough analysis of marriage and vital statistics. One of the most interesting observations is that the first interracial marriages were between Hawaiian women and white men from the United States and Europe. The men were better husbands than the Hawaiian men, prospered economically, and were given social status and distinction in the native culture. On the other hand there were few marriages of non-Hawaiian women to native men, and these were unsatisfactory. The first type of marriages were, however, the most common and produced an attitude of tolerance toward mixed marriages quite unusual in other areas. The author describes the factors affecting mixed marriages with each of the different races and nationalities. His discussion of the influence of the family traditions and ancestor veneration upon mixed marriages of the Chinese and the slowness with which they are assimilated is particularly interesting. As might be expected the divorce rate is higher than for the United States or even the Pacific States. Social disorganization occurs much less in the plantation life where the national culture can be maintained and is much more common among the poorer classes of the cities. The whole situation has resulted in a most unusual tolerance for racial and national differences and the author predicts an amalgamation and complete assimilation in the course of time if present tendencies continue. The book is full of suggestive insights into the psychology of interracial relations, comparing the situation in Hawaii with other culture areas.

Cornell University DWIGHT SANDERSON

Psicologia delle Abitudini. By GUIDO OLIVIERI. Milano, Fratelli Bocca, 1937. Pp. 113.

This book by Olivieri is an elementary text of the psychology of habit. It is intended for the layman rather than for the professional psychologist although, as often happens in popularizing scientific knowledge, it is somewhat too technical for the layman, and not sufficiently meaty for the professional. It is the author's hope that the book will contain information relevant to the elucidation of educational procedures.

Olivieri is eclectic in the enunciation of principles of habit formation. Except for the law of repetition, no other single principle obtains extended treatment. The essential emphasis throughout the book consists in the categorical treatment of materials; facts are placed in convenient rubrics, although Olivieri cautiously admonishes that such classification is not entirely justifiable.

The book may perhaps be best described as one replete with many definitions of habit phenomena; new terms are invented when necessary. It is interesting to note that the descriptions and examples of habit phenomena are far more illuminating than the definitions. The personal opinion of the writer appears to play a rather prominent rôle in deciding psychological questions. Bibliographic citations refer to general texts rather than to original experimental investigations.

The book is by no means complete. For example, Robinson's book on association and Guthrie's book on conditioning, two important guides in the psychology of habit formation, are nowhere mentioned. Olivieri gives no indication that he has exploited the tremendous wealth of factual material in the field of the psychology of learning.

To the Italian-reading layman, Olivieri's book will probably prove of value as an introduction and guide to a certain phase of psychological information. Were it to be translated into English, it would compete with many popular and semi-technical treatises of greater value.

Vineland Training School ANTHONY J. MITRANO

Surprise and the Psychoanalyst. By THEODOR REIK. Translated by Margaret M. Green, New York. E. P. Dutton and Co., 1937. Pp. 294.

This volume is devoted to the author's hypotheses regarding the nature of the mental processes which take place in psychoanalysis. The central core of these activities as they take place in the analyst is regarded by him as a conversation which occurs between the unconscious of the analyst and that of the subject. This communication between the two unconscious minds is a form of telepathy which is not "supersenuous" but "a direct psychical communication through . . . archaic, rudimentary surviving senses." The unconscious of the analyst receives these data, their meaning, and then comprehends them.

This last process is the first stage in which conscious and logical thought is involved. The line of demarcation between the process of comprehension and what is frequently called rationalization is difficult to distinguish. Since the author points out in his chapter, *The Nature of Comprehension,* "that errors in our psychological assumptions need not by any means prove useless," it is perhaps beside the point to raise the question of the similarity between these two processes.

The volume also has sections devoted to attention, wit, memory and reminiscence, reflection, anticipation and thought.

The translator has rendered the work in a very creditable style. She translates Freud's *gleischschwebende Aufmerksamkeit* as "poised attention" instead of Brill's rendition, "mobile attention."

An index is appended but its usefulness is somewhat limited since half or more of the citations are proper names.

University of Newark FREDERICK J. GAUDET

Construction of Personality Scales by the Criterion of Internal Consistency. By RAYMOND FRANKLIN SLETTO. Hanover, N.H., Sociological Press, 1937. Pp. vii, 92.

This monograph is of interest to those who construct personality scales, particularly scales of social attitudes, and to all those who take the problems of item analysis in general seriously. It reports a thorough and detailed study of some of the crucial factors entering into the use of extreme segments of distributions based upon total test scores for the validation of items composing the test. Among these factors studied were: the number of subjects needed to insure stable coefficients of item validity; the effect of using different populations, *e.g.* high school versus university levels, male versus female, employed versus unemployed; the proportions of the tested population to use in the two segments; the effect of omitting in turn the contribution of each item to the total score when that item is under scrutiny; whether the same item can be diagnostic in more than one scale (six scales on attitudes were investigated); and whether or not the study of items by the criterion of internal consistency may be used toward an analysis of variables in attitudes.

One or two statistical innovations are proposed, one of which is a short-cut for computing a critical ratio directly from raw scores and another is a new indicator of item validity which the author calls the "scale value difference ratio."

The monograph closes with a theoretical discussion of the nature of attitudes and of internal consistency. A short bibliography and an index occupy the final pages.

University of Nebraska J. P. GUILFORD

The Human Machine. By JOHN YERBURY DENT. New York, Alfred A. Knopf, 1937. Pp. vii, 294.

A distinctly popular yet scientifically stimulating outline of a mechanistic view of psychology. The author, an English physician, extends Loeb's tropistic theory and Pavlov's work on conditioning in the lower animals to include man. The evolution of behavior from its physical bases is rapidly sketched, touching on geology, evolutionary biology and physiology. A critical reader will find many speculative hypotheses stated without due qualifications, but on the other hand many of our implicit beliefs of mechanistic science are brought out into the open for a much needed airing and inspection.

Students of applied, borderline, and abnormal psychology should find helpful leads from this physician's experience on the problems of sleep, hypnosis, suggestion, and psychoanalysis. The general reader should find it a distinctly interesting and pithily stated viewpoint which is probably much sounder than other books they are likely to have read on popular psychology. A "debunking" of the psychological aspects of medical treatment is particularly interesting.

Northwestern University ROBERT H. SEASHORE

Aptitudes and Aptitude Testing. By WALTER VAN DYKE BINGHAM. New York and London, Harper & Brothers, 1937. Pp. ix, 390.

This useful volume contains a theoretical discussion of the nature of aptitudes and a detailed treatment of the major forms of test, showing the advantages and disadvantages of each. Fields covered include measures of aptitude for manual and skilled labor, clerical work, engineering, law, medicine, surgery, dentistry, nursing, teaching, music, and art. The book is apparently aimed less directly at the psychologist than at the clinical worker, the personnel manager and the vocational counsellor, who will find the test descriptions and instructions in the Appendix to be particularly useful. In fact, it may better be described as an extremely careful compilation, than as a strikingly original presentation.

University of Illinois GILBERT BRIGHOUSE

The Psychology of Belief. By HELGE LUNDHOLM. Durham, N.C., Duke University Press, 1936. Pp. 245.

The author in this book sets forth his views concerning the psychology of belief. The discussion falls into three parts: the process of belief engenderment; belief as an enduring mental disposition guiding human conduct; and belief as a mode of experiencing. He believes that the acceptance of a belief by the child is emotionally conditioned but later corrected by rational considerations, and that in adults suggestion is effective only upon emotional or rational grounds. As a mental disposition belief is classified as a thinking-striving disposition. Under the third heading he discusses the question whether or not there are certain attitudes in which man apprehends without coincidently believing; and he also presents a critique of McDougall's view of belief as a mode of experiencing.

The author's views are set forth clearly and interestingly; but the book has the flavor of the 19th century. There is no reference to the experimental literature, the only books on Child Psychology that he mentions are those of Jersild and Piaget, and no consideration is given to the many studies on the measurement of social attitudes in which beliefs are involved.

Cornell University H. P. WELD

Self-Consciousness Self Treated. By A. A. ROBACK. Cambridge, Sci-Art Pub., 1936. Pp. 265.

This little book constitutes a revision of the author's earlier *Self-Consciousness and Its Treatment* (1931). Some material has been added and certain sections have been rewritten. Like its predecessor, this volume makes a specific appeal to the layman, attempting to provide some insight into the causes, character and correction of personal problems involving feelings of inadequacy in social situations. The discussion is highly popularized and catholic, the author citing as evidence for his statements the writings of academic psychologists, psychoanalysts, literary and artistic figures, and those men of eminence in practical affairs.

It is the reviewer's opinion that there is very little in this book to interest the professional psychologist. For the general reader, it should be at least as informative as any of the popular discussions of personality found now on the market.

The text is supplemented by a series of "Questions Covered by this Book," a brief bibliography, a register of names and an index.

College of the City of New York W. S. NEFF

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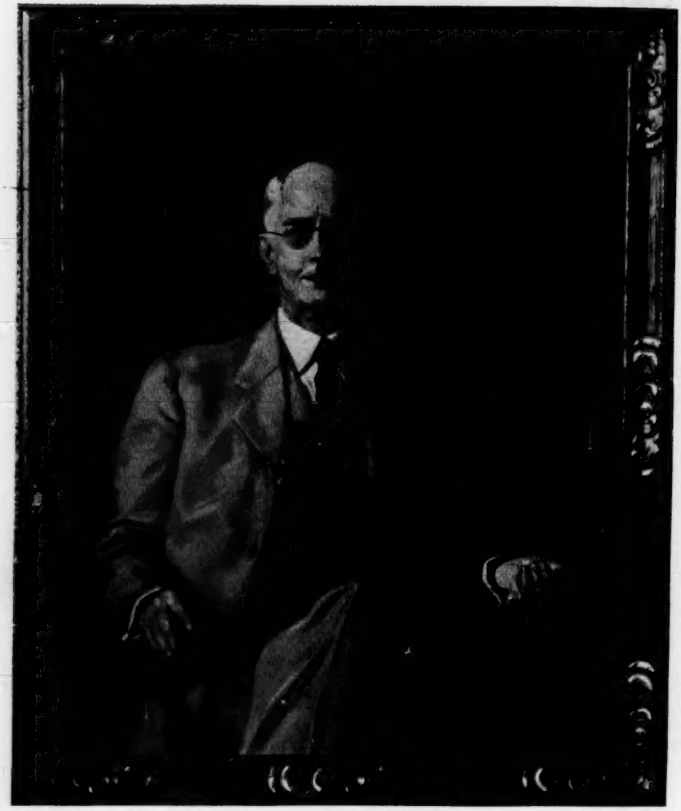

MADISON BENTLEY

Cornell University, 1898-1912; 1928-1938
University of Illinois, 1912-1928

(See page 579)